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Particles and Fleids-Interplanetary Space

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loatiest für Astonomie, Katlenburg-Itadau 3, Mact Settamy!

Taking recent obsatvacions of she differential tudial gratiagus and energy spaces of quiet time comprete pattins of different energies and maswer and over a large beliecentric radial drawner from 0.1 to 18 AU into acrount, we above that the transport equation for these verticles ifobsar-Timek oquation for the radial diffusion trefflicted, which then can be tolved aralysically. For coargank Orium and Oxygen rucisi we then discuss to edited and defendance of the diffusion trefflicted to the discussion of the discuss of earliest defined and oxygen rucisi we then discuss to exiled dependance of the diffusion toofficient. 1. Ceaphya. See., Stue, Paper 140619

SILO COSMIC RAYS
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S. F. Ruggal (Barsos Roseerch foundation of The
fearbilm issistate, University of Onlinera,
Remark, Onlinera 1971) S. T. Isurulani, M. A.
Forecans; C. H. Tasa, and E. J. Smith
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naguetic loop). J. Geoghys. Res., Blue, Caper 1AR759

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80x 1000, Boulder, CO 00307)
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sophic of mapping soler wind structures seen
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the cegion of the stream from:
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Particles and Fields-

ionosphere

ctaft (Voyagar I and 2, Seiton I and 2, and IMP-S) were used to analyze the flow bebind on interplanetary short. The shock was followed by a turbulent sheath in which there were lerga flutteations in the planetary short. The shock was followed by a rurbulent sheath in which there were lerga flutteations in the short was selected in the second to the magnetic field. This is turn asset followed by a region (magnetic toud) is which the magnetic flutteating oserly parallel to a class, consistent with the passage of a magnetic loop. This loop setemded at least 100 is longitude between 1-1 AD, and its radiet dimeasion ass approximately 0.5 AL. in the cloud the field except was bigh and the density and the field except was bigh and the density and the field. The total greasure incide the cloud was that of the ongestic field. The total greasure incide the cloud was higher than outside, inplying that the cloud was higher than outside, inplying that the cloud was higher than there of the presont glass, indicating that the cloud was not driving the shock at this detence. It is nowed laster. An acceptant larry fill smoot was observed at the rest of the cloud. It was bounded by current sheare whom a relations were preserved over at laster 0.12 AU and which were refacted to the place of maximum ascience of the larguetic field to the cloud. (Shocks.) Significant horizontal wind gradiants are often observed in the worldlonal direction, but not in the consi direction. Near midelight segmentally, during both the equinor and summer months, the equatorward wind is eften greater to the north of Areche then to the coult. We interpret this as shaing an effect of the passing oil the midnight equatorial propers maximum to the south of the nici ion. Heastcomin of our treatment of the south of the high ion the south of the high ion of the deed show that, between 0100-0200 LST, the neutral temperature with the interference of incommental temperature to the south of Areche is enhanced by acces 40°s over that to the south J. Cooghys. Res., Sing. Onger 140519

THE AUBORAL 2145% FRATURE

A. Deigerne (Hervard-Saithmoolem Genter for Setrophysics, Cambridge, NA 0218 USA) G.S.
Victor and T.-V. Hartquist

Laboratory data are used to argue that the excitation of the N it doubtet mar 2145 A by electron impact on No occurs through the sjection of an electron iron the 2000 grabini. The tross section grabely accessed to 16 cm², so is required if electron impact excitation of N; it the source of the autors i feature. By attaposition along the impact excitation of N; it the source of the autors if sarrers. We astimate a lifetime of 3.8 ms, to barmony with recent so initio calculations, the accurations then imply a rate coefficient for quenching of N*(15%) ions in the atmospher of the coefficient for quenching of N*(15%) ions in the atmospher of the opinys. Ras. Lett., Deper 12075

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PIELD I INE EQUIPOTENTIALITY AND ION-NEUTRAL
COLLISION FREQUENCIES IN THE DYNAMO REGON
DEOUCED FROM SAINT-SANTIN ION ORIF! MEASUREMENTS
C. Taleb (CNET/Cantre de Recherches en Physique de
I'Environnement Terrestre et Plantiete, 34-30 rue du
I'Environnement Terrestre et Plantiete, 34-30 rue du
Genéral Lecterc, 92131 [asy-ley-Moullotaux, Prancel
M. Blanc

We analyse three-dimensional ion drift data from he Saint-Santin incoherent scatter facility to last operior mentally the theoretical description of ion transport to the knowpheric dynemo layer, and io deduce electric fields and ion-neutral collision frequencies from the observed drifts.

Using e geometricel representation of the man momentum equation, we show that it middle fall tubes because horizontal neutral wind influences ton moiost be both parallel and ethnecoal to the lied lines in the horizontal neutral neutral contained in a threa-dimensional long drills measurement le réducinf, thus permitting to check the standard theoretical description of foreophisms of extraordynamics in 199 with description of foreophisms of extraordynamics in 199 with description of foreophisms of extraordynamics in 199 with profile on can deduce the north-double perpendicular profile on can deduce the invince of the profile function of height is to the compositant of the electric field function of height in the interestinal satisfies variations remain within the appendicular theoretical assumption of equipotential field lines.

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Earthquake Seismograph Development: A Modern History—Part 1

Ben S. Melton

The years from 1948 through 1978 saw numarous changes in alectrodynemic-type eerthquake seismographs. During this period, these seismogrephs and thair aesocieted amplifiers, recorders, timing systems, and power supplies were sdepted for worldwide service under meny operating conditions. These developments required endied to e better understanding of the fundamental limitations on design, ultimately ellowing small but a daquetely eensitive inetruments to be built for instelletion in cesed holes, thereby evolding undesired local eurface disturbances. The recording system developed within this period permits reedy review and compact storage of seismological date.

Introduction

This hiefory of development of modern eerthqueke seismographe covers tha period from 1948 through 1978. This euhor's involvement with many decisions and occasional conributions la documented by personel records end some pubishad reporte. Soma personal recollections of several individuals who were involved over the seme period of yeers are included. All of the well-known American seismologists whowere active during that period intluanced and supported the developmenta by their advice, so tha engineering advances described hera were of e netura to forward the eelsmological ari in a practical manner.

inwriting euch e history, ona needa to compose a prasentation easily followed by the reeder rather then to follow e strict outline of datee. My choice is to present first the eequential history of eelemometers, followed by thet of emplilies. than recorders, end finelly, timing systeme. This involvaa e elight repetition of materiel for the case in which e modulator hee become e part of the aeismometer, but in gansal, the ecquanca of developments was independent for seismometara, emplifiers, recorders, and ilming systems. However, because of the length of this chronicle it has been separated into two parts. The first part will cover seismomelers, the eacond, tha remeining componants. For the reader's convanience, the figure numbers will continue through the secondpart, which will be published in a forthcoming issue.

Prior to 1948, eerthquake selsmology in thie country had an acadamic beckground. As e rula, e aaismologist would purchase or hava built e salsmograph instrument or instruments suited to his Interast In particular seismic phanomera. The different apparant surface speeds of asismic phases composed of compressive end shaar wavas anabled tim loinfer the distance of a given earthquake. Charecterietically, one instrument or salsmomalar might have a epringsupported mass constrained to move vartically and with a

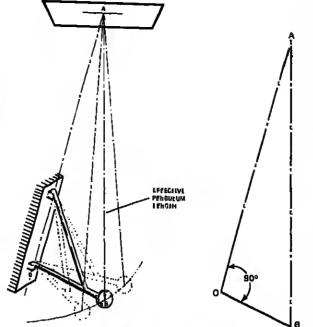


Fig. 1. Geomatry of a horizontel-componant seismomater, abowing the relation of its hings exis to the vertical.

neturel period of ebout 1 s. A different instrument, or rether two more instruments, would have maseee hinged on a vertical meet end constrained to move horizontally. These selsmometera would be oriented so that one could respond to north-eouth motion, the other to east-west motion. Their pariods would be on the order of 2 or 3, sometimes as much as 20 s. The short-period verticelly responding instruments would best reapond to the refrected compressive weves that treval through the earth's interior, while the horizontel mode instruments would respond to horizontal components of the longer-period sheer waves.

To record distant eerthquekes, the motion of each seismometer had lirst to be magnified by mechanical, optical, or electrical means. The early machenical systems were assily anelyzed in terms of response to earth movement, end these instruments were well covered by Dewey and Byarly [1969]. Thair history of these instruments anded with the beginning of the 20th century. They mentioned the electrodynemic seismograph with gelvenomeler, which wes introduced by Galitzin [1903], but did not discuss il.

When Prince Borie Borisovich Golilsyn (Galitzin) coupled the already well-known gelvanomaler to a selsmometer pendulum through an alectrical coll moving in a magnetic field. he laid the foundation for engineering devalopment of the modarn electrodynamic eeismograph. Gelltzin's gelvenometer mirror daffected a light beam which was focused on sensitized paper that was carried on e rotating drum, thareby trecing a waveform that wes related to the earth's vibration. Selemologiets tollowed thie aarliest documented work by davieling various models for different purposes. Among batter known nemes within this country ere those of Wannar | 1929|, Ben/off [1932], and tha W. F. Sprengnathar Instrument Compeny, Inc., of St. Louie, Mieeouri, which built eelsmometers for various aelemologiete. In general, the alectromagnetic eelemogreph in usa until 1950 employed this photogrephic registration on film or paper wound eround a clowly roteling drum. Tha drum wes transleted elong ite axis to ellow sevaral hours of recording on the sama etrip or sheet. This system, the alectromegnatic or alectrodynamic saismomatar with its associated galvanometar and photographic recordar, provided high and controllsbia magnitication at periods of intarest. The salsmomater could now be inetalled in a location less subject to nearby disturbances, and the recorder could ba located more accessibly. Such was the elatua oi most instrumants in observatoriae belore about 1950. Many observatories still use this errengament.

Howaver, the development of nucleer weapons after 1945, and national concerns about the possibility of clandastina tests of euch waapons, led to demende for eoma meene of delacting euch taete, seismogrephic monitoring being one obvious choice. In 1947, Chief of Steff General Eleannow assigned thie tack to the Signal Corps. With the reorgenization that resulted from the emergence of the U.S. Air Force as a eeparale branch of the armed servicae leter that year, the tirsf sacratary of defanse, James Forreetal, reconfirmed the assignment to the Air Force Office of Atomio Energy, Funds becema availeble to the office in 1948, and s staff of civillan scientists was assembled under a military etrudure. J Allen Crocker of that staff hired line author as a geophyeicist in late

Raviaw of available information on eelsmogrephic ineiruments in 1948 and 1949 showed that none was adapted for repid manufacture and efendardization, which would facililata uea by anyone other than an exparienced eelamologist. However, basic knowledge of mechanical end elactrical deelgn was available in some government laboratorias. The David Taylor Model Basin in Cardarock, Maryland, e Navy facility, had already designed some 'long-period' horizontal component eelemometere for use in trecking eterm microselema. These were built by Reed Research Inc. of Washington, D.C. The Stanley Aviation Corporetion of Denver, Colorado, was low bidder on a contract to devalop 'short-period' thrae-componant eglamometers with associated amplifiers, etc., for the Department of Terresidal Magnetism of the Camagle Inetitution of Waehington, Both of these systems drove Brush Development Company amullipen recordere through vacuum tube amplitiers.

As distant earthquekes can produce ground vibrations with periods from a taw tanihs of e second to 20 to 30 s, aalsmometers heve usually hed neturel periods within thet range; It has been customery to have at least two sets, on a sat with natural periods of a second or two and another sat with tongor periods, somatimes 10 s or more. Two sats rather then one have been amployed for sensing dietent earthquakes boceusa thare exiets a high end continuous vibration of tha eorth, celted microsetema, in the period range trom 3 to 8 s. These microseiams ere ceueed by oceen wava ection impinging on continental shalves. In 1948 the microselems were well known, but only rerely measured in amplitude el verioue periods and many locations, although the Navy had an ongoing study of their propegetion speeds and directions raletive to ocean storme. On the other hend, the natural period of the Navy seismomaters wes e hendicep to the eludy of weok ehort- and tong-pariod earthquake wavee from greet distences. Thus the ecientitic staff under Air Force euspices directed ettention to eeperate sals-

mometera for short end long pariods. Ultimetely. Iha natural period designad into any earthqueke seismometer dapends upon the earth's grevity. Horlzonlei component instruments are designed like e 'gardon geta,' that lands to swing shut because its hinge axis ia eligned to intersect the verticel ebove the mass of the gete Itself. Vertical component Instruments must heve a spring lorce thei wilt neutrelize the aarth's gravity and ollow the mass to have e rast position within a timited trevel amplitude white seneing earth vibrotions. Figure 1 ahowe the principle ol the 'gorden gata,' in which the lorce of the earth's field along AB is reduced by the cosine of the angle OAB. The spring force that supporte the maes of e vertical component

Basic Mechanical and Seismological Problems

instrument should be lineer with respect to spring extension. and for a simple coiled spring this becomes a large phyeical dimension for poriods greater linan a low tanihs of a second. The tength of a simple vortical coiled spring that supports a mass must be such that its extension E is given by the lor-

$E = gT^2/4\pi^2$

where g is the accatarolion of gravity, T is the period in seconds. Thus for a 10-s period tha spring stretch E would be about 25 m. Atthough LaCosto had dovised his long-period suspension by 1934, and LoCosto and Romborg analyzed it In their 1942 patent of a force measuring device, it was not well understood by seismologists in 194B or even much later. when LaCoste was building and selling prectical gravity ma-

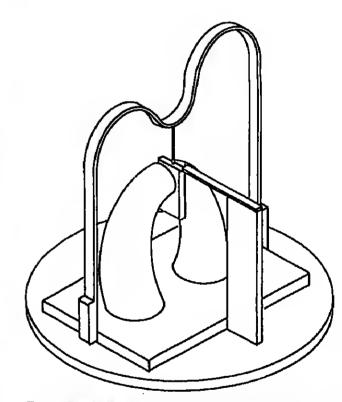


Fig. 2. Sketch of the spring suspension of the output coit of the Stanley abort-pariod vertical-component salamometer.

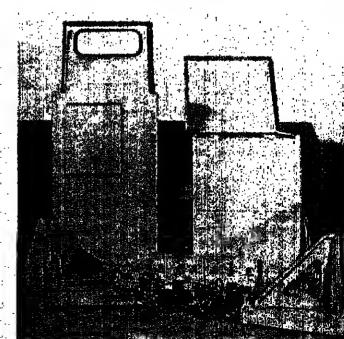


Fig. 3. DTMB horizontal-component selamograph system.



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Cover. Scanning electron photomicrograph of an experimentally produced fracture auriace in an Arkaneas Piver sand grain. Company of a quartz, excapt laidsper in upper left. Scale: photo width approximately 200. approximately 700 µ. Fraciographic markinga Include cleavage L.J. Gallagher, Jr., Energy Resources Group, Cillas Sarvice Co., 1888, Okla.)

GRAVITY

VERTICAL

MAST

Fig. 15. LaCosta euspension ea employad in the symmetricat tri-

Justilication of the Mess Requirement for the

axlet salsmomotar; & represents the angle of tilt.

Throughout the period covered by this history, justillcation

of the magnitude of the seismometer's inertial mess was a

major concern. The mess had to be sufficient to doliver ade-

quete energy for recording minimal earth vibrations. On the

other hand, an oversize mass would increase problems of

seismometer designed to detect weak long-period earth-

queke wavas. The practical example taken was a 10-kg

In 1963, using NBS Report 7454 as the reference, I made

calculations to determine the minimum eccoptable mass to: a

msss seismometar, which had a naturel period of 15 s, close-

and it was to be used in a phototube amplifier, a device which

In NBS 7454, $\omega_{\rm o}$, $\omega_{\rm g}$, and $\omega_{\rm m}$ refer to the natural angular frequencies (radians per second) of the seismometer, galva-

nometar, and geometric mean of these trequancies $(\omega_0 | \omega_g)^{1/2}$.

respectively; ψ is the ratio $\omega/\omega_{\rm m}$, where ω is the variable; $\lambda_{\rm o}$.

 λ_{n} end λ_{n} reter to frections of critical damping for the sels-

mometer, galvanometer end geometric mean $(\lambda, \lambda_0)^{1/2}$, respectively; y is taken ee eerth displacement, and θ refers to

tha anguler dellection of the galvanometer coli, so the frec-

en of coil dellection. Similarly, a fraction M/K is the ratio of

 $4\lambda m^2 M/K (y/\theta)^2 = \phi^{-6} + dy^2 + B^2 - A^2$

 $A^2 = 2(\omega_0^2 + \omega_0^2)/\omega_m^2$

seismomatar mass to gatvanometer moment of inertie.

Equation (B.3.22) In NBS 7454/NBStR 76-1089 Is

tion v/θ represents the earth displecement in meters per radi-

ly coupled to a galvanometer that was recently designed by

Forest K. Harrts of NBS. That galvanometer had a natural

period of 100 s and a moment of inertie of 4 × 10⁻⁶ kg m².

will be described in part 2 of this history.

TRIFLEXURE

Electrodynamic Seismometar

hendling and shipping.

where

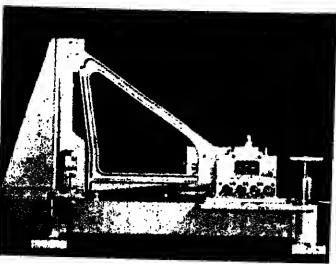


Fig. 4. DTMB horizontet-component selemometer.

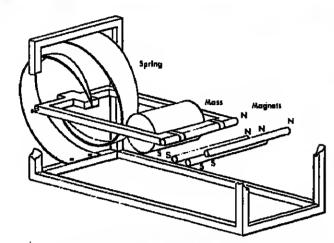


Fig. 5. Sketch showing principal construction teatures of the OTMB varticei-componant seismometer

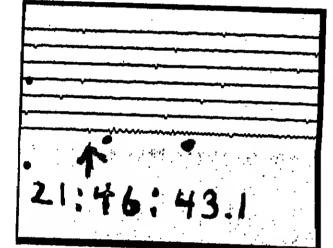


Fig. 6. Seismic record trace of the Entwelok nuclear explosion of July 24, 1949, at 21 h 34 min 59,7 s GMT.

Early Designs of Sansitiva Salsmographs

The Stanley short-period seiamographs and the David Teylor Model Basin (DTMB) long-period selsmographa were available in 1948. The Stenley instruments provided vacuum tube amplification of the voltage generated by a coit moving in the flux Itald of a permanent magnet. The magnets used were surplus magnetron magnets. Use of these was a factor in allowing Stanlay to submit the lowest bid to the Departmani of Terrestrial Magnetism (DTM). The vertical (component) Stanley aelsmomeier used tha coll as its masa. The Impregnated coil was supported from a strip of spring phosphor bronze (later replaced by 'iconal') that was fastened rigidly at its onds but bent into a ahape resembling a 'bishop's hat, a name which atuck to it at the tima. Figure 2 is sketched to show the essential parts of this device, which, by its nonfinear force, tanded to keep its vertical dimensions within reasonable bounds while supporting the mass-coll. This arrangament was never successfully stabilized, however. The horizonlei component Stanley setsmometer was br gorden gaie principto. Figure 3 shows the DTMB sasembled system. The DTMB aelsmometers did not generale a sotsmic signal from a colt moving in a magnetic field. Instead, they used e capacitance bridge, one arm of which woa the capacilance between a 'condensor button' and part of the pendulum. Somo mechanical dampting was provided by a dashpol thal contained damping liuld.

The capacitance bridge natwork was led by 100 kHz from a crystal controlled oscillator and buffer amplifler. When the bridge was balanced—the pendulum presumably centered in its irovei-ihare was no stgnal output to an emplifior-demodulator combination. Any diaplacemant of the psindulum unbalanced the bridge, supplying a 100-kHz signal with magnitude prosumably proportional to displacemant and phase depending upon direction of displacement from the balance point. A phase-sensitive detector, or demodulator, provided a signal et aelsmic trequency. This eelsmic aignal followed two paths. On a weathrough amplitters to the Brush recordar, The other path was through yet enother amplitier to a positioning electromegnet whose iteld was arrenged to oppose the field of a parmanent magnet mounted on the pendulum. Such a negative feedback reduced the natural period of the pendulum, thereby reducing sensitivity at the longer periods by allectively increasing the passband for selsmic signals. Figure 4 ahows the OTME horizontal component seismometer. Tha

alectromagnat leadback case is back of the pandulum in this

By mld-t 949 the DTMB group, undar Gaorga Cook, had built an exparimental long-period vartical component selsmomater whose principles are illustrated in Floure 5. The spring force here was applied as a torque at the hinge end of a long arm that supported the mass, and several fixed permanent magneta offered a measure of control and stabilization by opposing the field of a magnet mounted on the aelamomater arm. The centering of the mass was aided by proper positioning of megnats below tha arm, and the period was affected by the magnet horizontally opposite the arm, producing pariods as long as 30 a or more. The torque assembly was comprised of atrips of spring metsl which had low-temparature coefficients of expansion and rigidity, but the aystem could not be stabilized for actual earvice and was never de-

One set of the DTMB horizontal component salamographs was put into exparimental fiald servica by Baere and Heroy, a parinarship between Roland F. Bears and William B. Heroy, Sr., In Troy, New York. Of that organization, ataff membera active today include Jack H. Harnitton, Braden B. Leichliter, and Martin Gudzin, all currently associated either with Teladyne or Teledyne Geotech in Garland, Texas, hereaftar referred to aimply as 'Geotach.' Seismologist Carl Romney, a graduale student recommanded by Perry Byerly, was with tha Troy orgenization originally.

The DTMB salsmographs were in the field near Troy, New York, and oparating at the time of the magnitude 8.7 earthquake of August 15, 1950, which was located 28.5°N, 9B,5°S (eastern end of the Himalayan range). But when word of the quake was received through Carl Romney, 'Brad' Laichliter vialted the obsarvatory and found tha oparator asiasp. The excuse: 'When the pens went wild, I dadded it was (inatrument) noisa and shut it down.' However, conalderation of ihe logisiica problems involvad in supplying atorage batterias for vacuum tube lilaments plus large quantities of dry bateries for plate current resultad in discontinuance of the manufacture and davelopment of both Stanley and DTMB instruments. This would have happened even had it been posalbia to improve them. Power aupplias with long-term stability and which ware lad from the ac power line were not available In 194B and the aarly 1950's.

Recensiderations of Practical Seismographs and Combinations

The disappointing experience with these efforts to create sophisticated seismograph systems lad to reconsideration of commercially manufactured instruments. Investigation ahowed that a Banloff short-pariod salsmometer, with galvanometric ragistration on film, located in California, had clearly recorded the Entwatok nuclear explosion of July 24, 1946, that was known es 'Blkini-Baker.' The print of Figure 6 shows this record section on the lowast trace. The square pulses on all traces are 1 min time marks. This record was to no sensa surprising, but its existence, and political expediency, suggested that the best course was to procure and inatali Beniofi inatrumente as quickly as possibla. Hugo Benioff and Francis Lehnar of Lehnar & Griffith allowed Geotech to update menulacturing drawings, and Geotech put both verti-

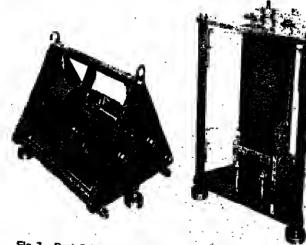


Fig. 7. Banloff short-period seismormetere: (e) vertical component, (b) horizontal component.



eson selemometer and case.

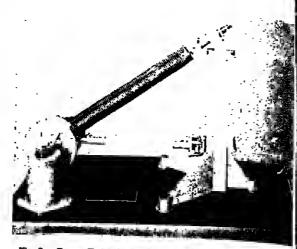


Fig. 9. Prese-Ewing long-period vertical-component seisme with LeCoste euspension.



Fig. 10. Geotech long-period vertical- end horizoniel compose selemometers.

cal and horizontal seismometers into production. Theseve sions are shown in Figure 7.

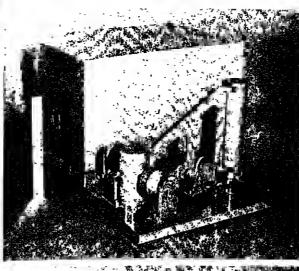
Benloff'a original papar, published in 1932, pointed out that the inatrument'a magnetic structure (tachnically, a variable reluctance atructure) had the effect of raducing springs ness, thereby shifting the natural pariod slightly shows and second. Also, that paper discussed the advantages diusing a long-period (i.e., 14-s) galvanometar with his short-pend aelsmometer. By 1957, Banloff had put in service eseismograph designed to respond to the normal dilatetional modes of the earth'e vibration. He housed one of his varieble reluc tance selamometers in a stiff cylindrical staal chamberiore duca its reaponae io barometric pressure variations. To this selsmometer he connected a gelvanometer that had snatral period of approximately 10 min. The seismometer paid was adjuated to about 2 e. The external critical damping # slatanca of the galvanometar waa 135,000 ohms, snd the transducer winding had a resistance of 135,000 chms. To reduce the response to short-period waves, a capacitod 200 μF was shunted across the transducer, followed by θ 135,000-ohm realstor in saries with the galvanomsier. This arrangement makes the response constant to ground displacement within ±3 dB from 2 to 6000 a. When capacitor and resistor are removed, response to valocity is constant over the same range. However, today's nagativa attitudes about galvanometers have tended to close this systue, and though it was investigated by Wanner [1929] and reinvestigated by Wanner [1920] and reinvestigated by gated by the National Bureau of Slandards (NBS) shout 1960, in a study by D. P. Johnaon and H. Maihason of the Bureau,*

in addition to their the cretical studies, Johnson and Math eson, with the aid of mastar machinist Hanry A. Schmid. 250 of NBS, designed a short-period vertical component sels. momatar in which the permanent magnet was used for the mass, while the electrical coll was mounted in the frame. Fig. ure B ahowa this instrument. A period of 0.B s was schiered by supporting the magnet mass from three levers, which the duced the force of very allff springs. The springs were made very compact and could be given a prestretch in their normal position. The effect of spring stiffness was reduced by 8 [80 tor of 10 in this manner; this was equivalent to making the springa to times as long. These instruments were quite rufged, and some of them eventually replaced the vertical conponent Benioff aelsmometars. Some datalis of this instrument were shown and discussed by Malton and Johnson

NBS Report 7454 was tiret issued in 1962. The final doc NBSIR 79-1089, was issued in 1979; but this report never enter the public litereture because its euthors declined to discuss earlies papers covering the same material, in lieu of such discussions in defined all of their variables and included those of the sarier lies ture, where appropriete, for the reader's reference.



Fig. 11. Geolech Model 7505A eelsmometer, showing ned



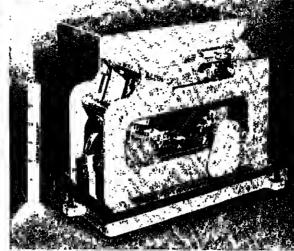


Fig. 12. Sprengnether long-period eelsmometers; (a) vertical component, (b) horizonial component.

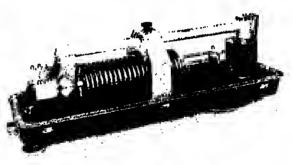
During tha study of this seismometer and others there was much discussion of how small a masa could be edequeta. Clearly, the greater the mass, the more energy available from sarih vibrations to be racordad. Also, the instrument selfnoisa power was believed to be inversely proportional to the mass. Both considerations suggested that there should be a minimum accaptable mass. Wolf discussed this in 1942. Byrne in 1961, and Johnson and Matheson about the same tims. With thase studies and other factors in mind, the 18-kg mess of tha NBS selsmometer was thought to be just adequale. Only years later dld review of earlier published theory, by O. D. Sisrkey of Geotech, Block and Moore [1966, 1970], and the present author, aetablish the fact that the damping energy was the only source of tharmal noise—the ultimate amit of usaful sensitivity.

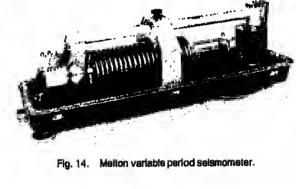
Of coursa, the total damping energy dapends on the mass, so if the mass is very small, the ebsolute damping must be very low-affactivety, the 'Q' must be very high. Also, It should be noted that the externel damping power of en alectrodynsmic salsmomater provides the only means of register ing its motion or, aquivalently, transferring information outside the Instrument. The Internal damping, including coll loss-8s, does not transfer information. This theory and supporting sariisr axpariments wera covered in a review papar by Mel-

Earthquakes and explosiona both produca seismic body and surface wavae; howevar, explosions ganerate relatively weaker long-period surface wavas then do esrihquakss. Thus to distinguish batween earthquekas end explosions, long-period selsmometare are desirable in association with shori-pariod aelsmometars, but axparience with the DTMB instrumants discouraged development until Ewing and Preas [1953], st tha Lamont Gaological Observetory of Columbia University, put into sarvice a long-parted vartical component seismometar that was built by Lehner & Griffith of Pasadena, Californie. Figure 9 shows this instrument, which was compensatad for varying air buoyency by an outrigged hollow sphere which had a volume equal to that of the salsmometar's inartial mass. This instrument amployed the LeCoste zero-length spring suspansion, thareby emphasizing its practicality. However, the salsmometer was not shielded against air currents or insuleted against temperature

The need for temparature stability and insensitivity to eir currents and baromatric preasure changes callad for an enclosed dasign for production. Accordingly, Gaotech provided e design with a base and an airtight heavy case of Mahanite. a cast-iron alloy, which was clamped into a gasket around the perimetar of the bass. The long-period vertical component was manufactured as Gaotach Model 7505A. The essociated horizontal componant was Modal 8700C. Both models are shown in Figure 10. The vertical component shown in Figure 11 hae a balancing weight whose position can be changed by a motor drive that adjusts the msss 'rest position' to its center of traval. This modal worked wall et natural pariods up to 15 s. but many inatrumants were unsteble at pariods greeter than 20 s, chiefly baceuse the LeCoste design was neither well undaretood nor wall executed, and pertly because of unsuspected paramagnetism of the elactrical coil form, which was later corrected. These instruments were put in service late in 1962. The problems with these instruments resulted in publication of the Maiton [1971] paper on the LeCosta sus-

Sprengneiher also built modarn vertical and horizontal long-period seismometers, which are shown in Figure 12. In a well-protacted environment these instrumants serve as well as those of Geotech. In 1952, Sprengnether long-parlod vertical and horizontal component seismometers were instelled es part of the World-Wide Seismogreph System operated by the Coast and Geodatic Survey of the U.S. Dapartment of Commerca. The vartical seismomaters have a tamperature compensator to adjust for gradual lamparatura changes, and both varticel end horizontel Instruments ere provided with metel covars with haatars end expended polystyrene covers over the matel. These covers are not sealed however.



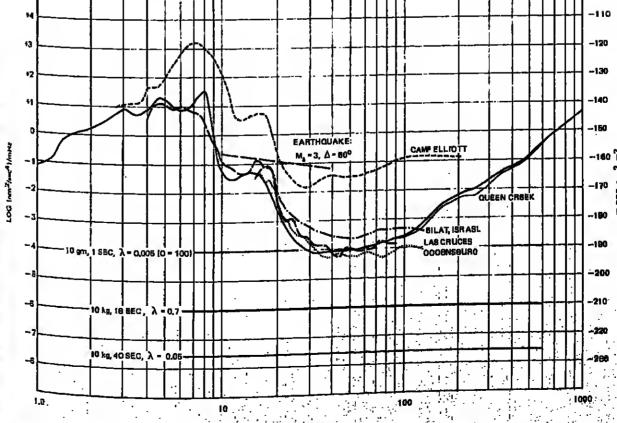


 $B = (8 + A^4)/8A$ As all quantities on the left aide of (B.3.22) are real and positive, physical reality demands that the right side must be positive for all values of ϕ . The minimum value of $\phi^{-6} + \phi^2$ occurs et $\phi = \sqrt[8]{3}$ and is $4\sqrt[4]{3}/3$. For the problem at hand we can take ω at midband, so that $\phi = 1$. Then, subatituting the angular frequencies, we find that $A^2 = 13.64$, $B^2 = 43.13$, so $4 \times 0.8^2 M/K(y/\theta)^2 = 2 + 43.13 - 13.64 = 31.49$ $y = 3.51 \theta (K/M)$ Substituting the seismometer's 10-kg mass and the galvanameter's moment of inertia 4×10^{-6} kg m s⁻², we obtain $K/M = 10^{-7}$, so that

 $y = 2.22 \times 10^{-3} \theta$ meters Experience had shown that we could observe and record a galvanometer angular deflection of somewhat tess than a microradian by ueing a phototube amplifiar with a good power supply. Teking $\theta = 1 \times 10^{-6}$ rod, we have $y = 2.22 \times 10^{-9}$ m at a period of 38.7 a.

When the above calculations were made, there was little information on the expected amplitude of microselamic noise at the longer perioda. The deta of Trotf [1965], Savino et al. [1972], Murphy et al. [1972], and Flx [1972] were not availabla. These daia were reviewed and collaied by Melton [1976], and it is interesting to reexamine the choice of a 10kg aelamometer mass with the long-period galvanometer, in ilghi of the laier Information.

Unfortunately, the spectral analysis presentation of a statlatical aampling procedure maska tha fact that at eny givan time the microseisms are nearly sinuacidal and mostly at one period. Similarly, earthquake waves usually have a maximum amplitude at some period that changes alowly, and it is this amplitude upon which detection depends. Therefore, wa nead to realize how microseisms over a narrow band are translated into a etatlatical value taken over a long time.



9, 13. Medium- and long-period apectra of earth noise plotted as squared acceleration per millihertz. The Queen Creek apectrum of Fix 1107 21.15. after Fix [1972]; la shown with two branches, the thin line lower brench representing the noise after aubtraction of the measured instru-mental noise [included in the upper branch. Elsewhere elong this curve the instrumental noise is a negligible portion of the energy represented! The Camp Elliott curve, after Heubrich and MacKenzie [1966], represents data from a southern Castornia ette about 20 km from the West Coast. References for the other curves are as follows: Las Cruces, New Mexico, Troft [1965]; Ogdensburg, New Jersey, Saying et al. [1972]; and Elliot to the curves are as follows: Las Cruces, New Mexico, Troft [1965]; Ogdensburg, New Mexico Saving of al. [1972]; and Ellat, lergel, Murphy et al. [1972]. Thermal acceleration energy for several assumed selemometers is shown by the horizontal solid lines, and a proposed frequency plot of en earthquake with surface wave magnitude of 3 at 60 epigentral distance is included in order to be surface. troluded in order to show the retailing between earthquake and notes energy.

PERIOD (seconds

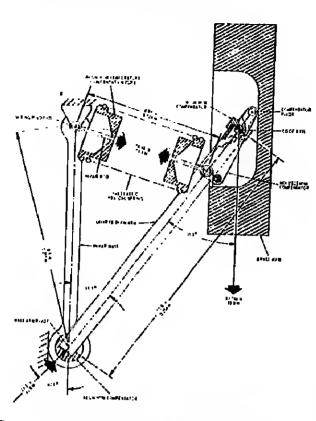


Fig. 16. Construction of Le Costo euspension in one element of the Idexiol sols mornoto

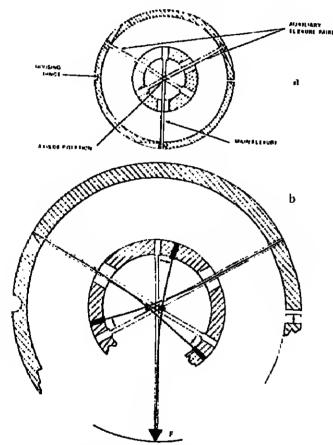


Fig. 17. (a) Basic configuration of triflexure hinge. (b) Introduction of force couple as inner member is rotated. Forcing open the outer housing at the slit on the right produces a tension torce F. As the crossing point of the tlexures moves ewey from the central axis, the lorce F tends to produce further rotation. The net result is to increese the eeismometer natural period.

Consider Figure 13, which is reproduced from Melton | 1976|, and examine the region which shows curve maxime trom 12 to 18 s. This curve should be interpreted simply as picturing a high probability that nearly sinusoidal microseisms will appear in this band, and by the seme token they reduce the probability of earthquake weve defection in this seme bend. As we cannot validly reduce any slettalicel value onergy to some specific value of energy at a single frequency, we must choose a bandwidth for conversion purposes. Based on comparisons of eerly vieuel measurements of microsolsmic amplitudes to the later etatislical troquoncy analysis, my compromise choice is one-third

Thorefore, in the peesband from 15 to 100 s, microselsms at 20 s or less should reduce the probability of detection over, ssy, e one-third-octave band centored at 17 s, 13.6 mHz. Taking an arbitrary value 1 × 10 1 (nm² s 1)/mHz, we have lor one-third octave e mean equere acceleration of 1.38 nm² s 4 end sn rme acceleration of 1.17 nm e⁻², which corresponds to an rms smplitude of 2.72 nm et 17 a or e peak-topoak empliftude ebout 3 times that velue, or 8.15 nm.

Thus, if we accept a dotection empilitude value of 2.22 nm over a flet passband from 15 to 100 e, we can conclude that the eolsmometer-galvenometer combination considered above hes a high probability of having an adequate detection; capability. However, in eny real system the seismometer would be connected to the getvanometer through a resistive network that has some minimal loss, so prudence suggests that choice of a much smaller seismometer mass would not be advisable unless e galvanometer that has a lower moment of Inertie were chosen also. For example, a Lehner & Griffith galvanometer Model GL-261 hee a moment of mertia df.2.6 × 10 ⁻⁷ ka m².

Earth Noise Studies

As late as 1958 the saismological literature disclosed very little information on the smalltude of microseisms and cultural noise relating to geology, geogrephy, time of yeer, or frequancy of occurrence. However, in 1949 the Navel Ordnance Laboratory (NOL), located in White Oak, Maryland, was easigned to investigate thase phenomena. No instrumente were evellable for this atudy, so e isboratory group under the direction of J. V. Atsnesoff, ister directed by Ben Snevely, undertook to build smell vertical end horizontal component seismometere for field deployment. These little seismometers, designed to go down a hole, used masses of about 100 . Most of the suspended mass of eech instrument wes in e flat plate centered between two fixed pistes, end the combinetion formed part of an electrical bridge that controlled the phase of e high-frequency carrier current, which was amplified end demodulated to give the low-frequency seismic signal output. The mess/piste of the horizontal component inalrument was mounted on the top end of e thin fist apring. The verticel component mass/plete was also attached to a ffat spring member, but a vertical coll spring was edded to offset grevity. Both components had a natural mechanical period of about 1 s. A petent issued to Atanasoff and Kolarud in 1956 reveels the detells.

These instruments employed electrostatic forces to modify their response. A controllable do potential difference between moving end fixed platea served to decrease the effective apring rete (restoring force), thus increesing the period to severel seconds. Blesing this potential in levor of one or the other fixed piste served to recenter the moveble piete. This recentering biss was provided by a long time-constant (~200 s) integration of the demodulated signal output, thereby reducing long-term drift. The demoduleted signal output was also differentisted end fed back to provide controlleble damping. The amplitied algnei output of each asismometer drove e golvanometer that deflected a light apot on photographic film, which was trenslated to provide the time axia. Also, the ampliffed signels were fed to Esterline-Angus chart recorders to monlior salamometer operation.

The NOL seismographs were deployed lete in 1949 end were operated by milltery paraonnel through much of 1950, eerving to relete microaeisms of different frequencies to different times, es oceanic stoms verted conditions of generation. However, these instruments were critical in adjustment, both me chenically and electrically, and not well suited to unaltended operation. Also, their locations were reatricted because they had power supplies that required connection to a commercial power line.

As experience wes gained in siting salamometers for earth noise studies, and aa more observatories were set up at numercus geologic locations, the construction of eelsmometer vaults was lound to be important. Finelly came the reslization that even a concrete veult beneeth the surfece required e means of entrence which, Il part of the structure, coupled the enlire veuil to the surface of the earth, thereby transmitting surfecs dieturbancee to the selamometer. Therefore, consideration was given to designing seismometere that could be pul down a deep hole end sdjusted, as necessary, by remote

Accordingly, efforts to meesure locel earth dieturbancee as a function of depth were begun under e contract with United Electro Dynamica Corp. (UED) to put e aeismometer at different depths in some ebendoned oil well hole end to measure the noise et each depth in comperison with the noise at the surface. Shell's Government No. 1 well near DuBola In Fremont County, Wyoming, was chosen for this etudy, which began in lete 1958. Many troubles were experienced with the Instrument aent downhole, end the mud level sank continually. Only in 1980 were reaults obtained that seemed to indicate the expected reduction of noise as compered with standerd instruments installed on the eurisce near the well. The well study was termineted in April 1960, but John Woolson of UED mede further notse measurements for varioua geological surface conditions and sites for e number of months lhereefter and on into mld-1961. Also, there were severel sttempts to correlate microselsms between eltes eeperated by about e half kilometer or more. Spectral enelysie was done by enalog methods, by moving e filter band over a repeeted esimple of the noiss on magnetic tape, this at higher tepe apeed in order to bring the algnele into the audio band.

The well meesurements were only the forerunnere of later studies too extensive to discuss at length. In mid-1982 e verisbie reluctence seismometer, based on Benioff a dealgn, wes

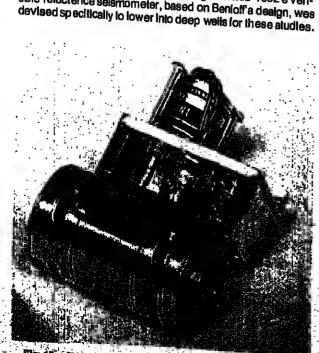


Fig. 16. Triflexure hinge end moler assembly. The reversible mo-lor serveit adjust the tension F, shown in Figure 17, thereby con-

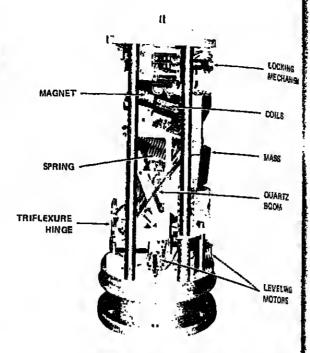


Fig. 19. Single module of the Irlaxial esismonsies.

This instrument hed e 100-kg mass end provided sufficient electrical output to ensure adequate sensitivity for measure e very low noise field at great depths. The first well surveyed Magnolia's Trigg No. 1, was located in the northaust parts. Tarrant County, Texas, on the present site of the Dellas Fed Worsh eliport. The well was about 3000 m deep, bottomedia

Tha Variabla Pariod Saismometar-its Concept and

In 1959 the author suggested, with a construction sketch, thet e verlable period a eismometer be devised for use by any aelsmologist for his particular interest. The concept was to provide the critical parts unessembled, to be put together by the Individual seismologist. However, funds were uneveilable until later, when discussions of the atomic test ban took place and the USSR representatives offered some of their selsmometers for comparison. As there were no comparable American aelsmometers available, funds were provided, and the Melton aelamometer (Figure 14) was creeted in this seemometer the 5-kg maas can be moved to or from the hings. and the spring tension can be adjusted by stretching or relaing the spring. A ateel tape attached to the spring is wounder or off e drum through e worm and gear mechanism for his edjustment. The natural period is variable from 0.5 to 7s. while the electrical circuit resistence required for damping mains nearly constant. Hamilton and Stephens [1962] INFO tion that this instrument was installed at the Delias Saismo-

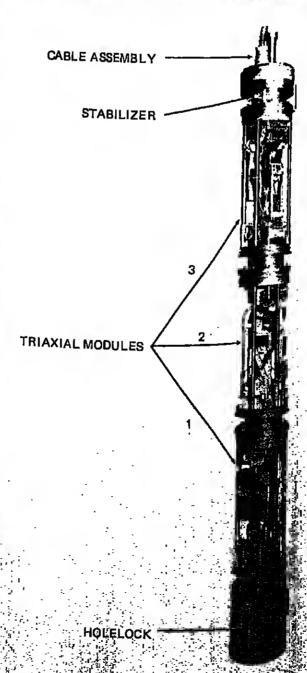
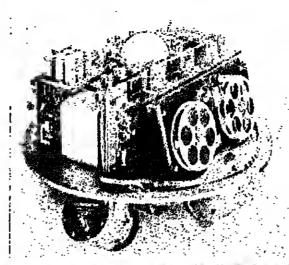


Fig. 20. Uncased assembly of the three modules of the reality elamqmeter, troubles with a hotelock medianism below and ter eboys:



elsmograph developed for the Scrippe Inetitution of Oceanography.

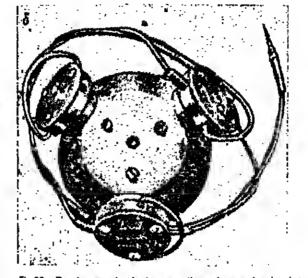


Fig. 22. Russien geophysical prospecting seismometer showing symmetrical triaxial arrangement of three of its sensors.

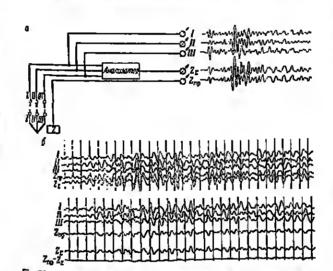


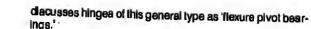
Fig. 23. Signel treces from the four sensors of the Gel'perin sels-

logical Observatory et Southern Methodist University (SMU) oprovide e flat "velocity" reaponse over the period range

The Symmetrical Triaxiel Configuration

Emphasia on adequate identification of long-period earthquake waves influenced the next development. The in-Strument was described end patented as en 'Anguler Composlie Salamometer,' but tt became known ee the 'Symmetrical Triaxial Seismometer.' In euch an instrument the orthogonal directions of response form equal angles of about 55° with the vertical. These orthogonal directions sensing acceleration components that can be rotated algebraicsily to the conventionet horizontal end vertical direclons, provided the physical orientation of the instrument is Known. The edvantage of such en arrengsment is thet all three spring-mess systems are designed identicelly, giving greater assurance of metching characteristics. Also, es the arm carrying eech mass is within about 35° of the vertical, the horizontel dimension can be lese. Then stecking the three elements verifically permits a slim design, suited to putting down s hole.

My notes show that this composite eelemometer wee described to an essociate on March 7, 1960. The ultimete mechanical design by Burnard Kirkpetrick of Geotech was underway in 1966, and an array of theee instruments was being installed near Fairbanke, Alaska, in late 1968. The patent Was illed in 1963 end issued December 7, 1985. The Individual elsmant masses were 10 kg because we had no assurance at the time that a lighter mass would be seequste. Eech LaCoste suspension was designed and adjusted to the 'ininits period position. Then the period was adjusted by changing the tension on a special triflexure hinge by wey of s motor drive. Figure 15 diagrams the LaCoste euspeniion.
The angle 5 is zero for 'Infinite period.' Figure 16 shows the basic and the control of the control basic construction of one element. Figure 17 Illustratee design principles of the triflexure hings. Figure 18 shows the hinge and motor assembly. A more complete description le given by Melton and Kirkpetriok [1970]. Weinstein [1965]



Figures 19 end 20 show e single module and en uncesed sasembly of three modules with holelock underneeth end e atebilizing device et the top. These instruments showed greatly reduced response to local surfece disturbences ceused by wind and atmospheric preesure variations, even though in some inatelletions the depth was much lees then plenned, because of drilling problems.

The symmetrical triextal configuration was incorporated into en ocean bottom selsmogreph developed for the Scripps Institution of Oceanography by Earth Sciences Division, Teledyne industries. Figure 21 shows the uncseed easem-

The symmetricel triaxial principle has also found its way into geophyaicsi prospecting. Gel'perin [1977] hae published a book which describes e polerizetion scheme of recording ell types of weves simultaneously. In this scheme, four sensore are used. Three of them ere oriented triaxislly, as suggested in Figure 22. A fourth aensor responds as en Independent vertical component. Figure 23 ahows signel treces from these elements. Trece Z_z is evidently the effective vertical formed by direct summellon of the triaxial component signals, while Z_{nn} is the independent vertical signal. The Z_{nn} - Z_{x} trace, if quiet, indicates a true amplitude match of the verticel component signal amplitude to the signal composed of the triaxial sensora end implies proper calibration of ell sensor

Principles end Practices for a Redicelly Different Seismomatar Design

Even as the aymmetricel triexisl was being developed and put in service, e new concept of mass-thermal noise rotationship was evolving. The reelization that the thermol noise of o selsmometer depended on its damping losses (rether than on ita mass) suggested theil e much lower mass and smollor seismometer could be devised, provided that amplitters could compensete for reduced selsmometer outputs. Briefly stated, the thermal noise (force) of e periodic system, electrical or mechanical, resides in its lossy elements. The system oscillations indicate the presence of some torce, including thermel noise, but the amplitude of mass (or spring) oscillation is only a messure of energy, not the energy source itself.

O. D. Starkey of Geotech reviewed the work of McCombie [1953], Miletz end van Zolingen [1953], and Milatz et el. [1953], and by 1966 hed composed a long handwritten Irealise which included a 31-page section on 'Active Demping in Selsmomeler-Amplilier Combinations.' Block and Moore [1966, 1970] showed how active damping could be applied in designing en eccelerometer, and I beceme fully aware of the principles in April 1970 when called upon as a consultant to eveluate the Block-Moore Instrument. Essentially, the proposal was to provide a very small quartz seismometer with the desired damping—say, 0.7 critical—by spplying negative

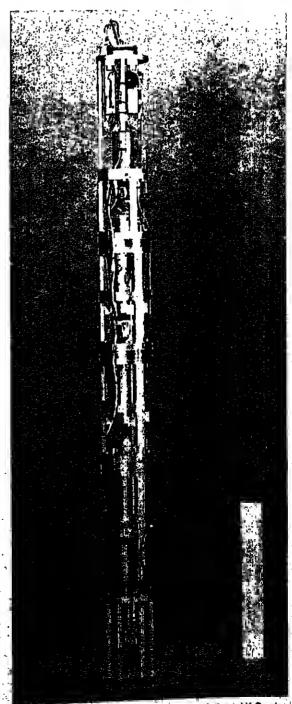


Fig. 24. Mechanical assembly of the force balance' K-S selsrig. 29; Meditaliou assembly of the nove balance N-3 sels-monatars, Geotach Model 36000, later known as the SRO selamograph system.::

feedbeck lores to the mass, proportional to velocity, rether than using loss damping of eny neture. The little mess would be part of a cepecitance bridge modulator to provide an electrical oulpul es the mass moved. A general discussion of this arrangement follows.

We have noted that the stectrical load of a conventional olectrodynamic seismometer provides the information output. So, if the load is eliminated, meens must be devised to senee mesa movement. This is feasible with a properly designed modulation echeme, which in itself produces nogligible mechanical reaction notas. A moduletor is generally underetood to be a device by which a low-frequency aignal modifies a high-frequency carrier. The moduleled carrier can then be amplified as desired, and a demodulator can recover the amplified low-frequency component. In this manner one avoide so-called 'one-over-f' noise, a characteristic noise injected by ell ective devices that control dc power (that is, ampliflers) and which increases dremeticelly at periods greater then 10 s. Figure 31 of pert 2, in the section on carrier ampliflers, illustrates this with factual dete.

Application of the ebove principles eventually made possible the development in 1970 of e more useful 'downhole' selsmometer-the Geolech Model 36000 seismometerknown locally as the 'K-S Selsmometer,' elter its designers Burnard Kirkpetrick end O. D. Sterkey. This seismometer can be lowered inside a 7-Inch (outside diemeter) 20 lb/ft API

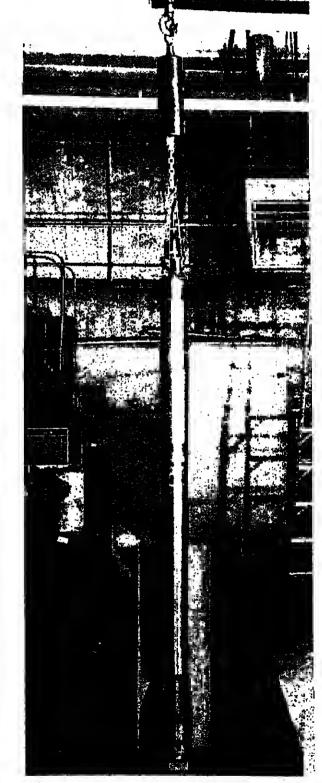


Fig. 25. Cased assembly of the Model 36000 seismometer, including downhole electronic components, ready to be lowered into a

casing. The uncased mechanical assembly sppeare in Figure 24. In order, from the bottom upwerd, ere shown the two horizontal components, the vertical component, end the air pulee mecheniem. An air pulee is fed to e bsil-end-sockel joint of the lop of sech component caes to free the joint momenterly and allow the case to seek a vartical position. This is necessary because, in ganeral, tha hola is not verticel. Figure 26 shows a cased asaambly, including electronic components, raady to go down a hole. These setsmometers ware put in service in 1975 as the Selemic Research Observatory (SRO) seismograph system, described by Peterson and Oreini [1976], Palerson et al. [1976].

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Ben S. Mellon, Irom Delles, Texas, received the B.S. degree in electrical anguneering from Rica University, Houston, in 1925. Following a sludoni engineering course at the General Electric Company and a short time as engineer with the Gulf States Utililes Company, Port Arthur end Beaumont, Toxas, he was employed by tha General Exploretion Compony, Houston, to do research and de-

velopment work in electro mognotic prospecting for oil, during the years 1928 to 1930. Late in 1930 ho ontered the field of seismograph prospecting with Geophysical Service, Inc., Daltas, and except for a short period, remained in that work until 1942, becoming associated with the Netional Geophysical Company, Dalles, from 1937 until April 1942 That yeer he joined the staff of the Applied Physics Lobotatory. The Johns Hopkins University, Silver Spring, Maryland, es e redlo engineer on the proximity-luce project. Later he was involved in development of optical and other methods for exemining supersonic flow in connection with remjai llight.

In December 1948 he eccepted appointment as e geophysiciet with the U.S. Air Force, in connection with the program to detect end identify underground nuclear explosions. Upon retirement from this Air Force program in 1965, he became an independent consultant.

Melton is a charter member of the Society of Exploration Geophysicists, e senior member of the institute of Electrical and Electronic Engineera, and e member of the American Geophysical Union and the Seismological Society of America. He is a registered professional engineer in the steta of Texas.

News

NSF Losing Earth Sciences Research Funds

Tha Earth Sciences Division (EAR) of the National Sciance Foundation (NSF) faces a diminishing finencial base from which to award grante for research, while the proposal pressure increases. Robin Statt, director of the division etated, 'Now that the Ocean Drilling Division has become a eeperate entity [within the Foundation] tha Division of Eerth Sciences has no major facility, and with the exception of COCORP, et \$2.8 million per yaar, we era a small eclence division, coneleting of tour programs—geology, gaophysics, gaochamletry, end petrology."

Brstt noted, howavar, that the flaid of earth eclences reagarch, which the NSF ettempts to support, has grown rapidly in the past decade. 'Growth (in terms of people arnployed in the flaid) is predicted to increase markedly, as the following quotation from Science and Enginearing Education for the 1980s and Beyond (NSF publication, 1980) at-

"Among tha adencae, growth (batween 1978 and 1990) la put at 40% lor psychologiets, geologista, statisticiana, and economiets. Occupations with projected allow growth includa etmospheric eclantiets, physicists and astronomars, end mathemeticiena, all of which are projected at 10 par-

'The everage grant has decreased in dollar value rapidly

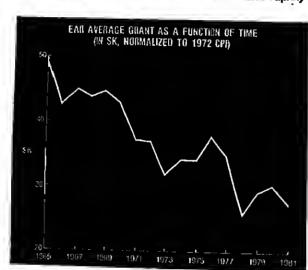


Fig. 1. Plot of the everege ennuel grent made by the Eerth Sciences Division (EAR) of the National Science Foundation as e function of time (in \$K normalized to 1972 CPI).

TOTAL NUMBER OF PROPOSALS RECEIVED BY EAR AS A FUNCTION OF TIME 1969 1971 1973 1975 1977 1979

Fig. 2. Total number of proposels received by the Earth Se-ences Division (EAR) of the National Science Foundation as a

during the past decade or so, Bratt said. In 1965 the averaga grant waa close to \$50,000.00 in the earth sciences. (Saa Figura 1.) In 1981 the averaga annual grant is about \$27,000.00. Inflation has caused the decreese, while the ratio of the budgeled dollar par inveeligator has remained lese than laval, and while the coat of research hes increased; instrumentation is not cheap: ona modern mass epectromater laboratory costs \$400,000.00, enough to aquip ten aarth scienca dapartmants thirty years sgo!"

At the same time, the portions of grants allocated to be apant on invastigator's salaries and institutional overhead

A major problem at the NSF Earth Sciences Division to day is the anormous number of research proposals. It is an almost impossible task to procass the propossis, much less fund tham. The NSF viallor today will see 10-15-fi sizeks ot proposals being movad about, warehousa siyle, by tok-Illi trucks. A current joka at the NSF is that essisien program managers are baing hirad just to enable the divisions to hire secraterias to handle the load of proposals. Congrees has repeatedly cut the staff and operation of NSF. but the work load continues to increese. The number of proposela racelvad by the NSF Earth Sciences Division's increasing by an exponential function (see Figure 2).—P15

HEAC-2 Completes Flight Mission

Tha second High-Energy Astronomy Obsarvatory (HEAO 2) has expended its control gas supply, complating its flight

The epacecraft wea launched Nov. 13, 1978. It carried the world's largest tocusing X rey talascope and an array of Imeging and anelyzing aatronomy instruments. During its extra-long litatime, it parformed thousands of studias of Xray-emiliting stare, suparnova ramnanta, gelaxias, and qua-

HEAD 2 is one of a family of threa highly successful ecientific satallitae managad by NASA's Marshall Space Flight Cantar, Huntsvilla, Ala. With 2 years and 5 months of opsrattone, HEAO 2, like ita predecessor HEAO 1, parlormad more than twice as long as its daalgn called for-a feat axpected to be equaled by the third observelory, which is still

Although it will leke years for participating astronomers to analyze completely all the data they received, importent data have alraady been obtained about the X ray output of normal stars, the composition of supamove remnents, tha distribution of mese in galexies and clueters of galaxies,

and the origin of the extragelectic X ray background. The epacecraft was opereting extremely wall, Marehall Cantar officiale reported, when it axpanded the last of its reaction control ges Saturdey attarnoon, April 25, and could no longar maintain its pointing attituda. Spacecratt and instrumant anginaaring tasts ware parformed until the betterlas ware dischargad, and on a subsequant orbit Sunday morning, when the solar panals were receiving aunlight, sil systems were powered down. Reantry and burnup are axpacted to take placa next year.—PMB [Sourca: NASA] 88

Petroleum Research Grants

Five earth sciences grants are available through the Amarican Chemical Sociaty's Patrolaum Research Fund (PRF). Thase grania are intended to againt 'advanced sciantific education and tundamental research in the "petroleum tield," which may include any field of pure scianca which ... may afford a basia for subsequent reaserch directly connacted with the petrolaum field, according to Justin W. Collat, PRF program administrator.

Tha grants are divided into threa categories, Collai said. The first, called type AC, generally supports graduale studants or postdoctoral fallows. Awarde may be up to \$15,000 per year for a maximum of 3 years. The second, type B, is lor faculty research with undergraduate students: in soademic dapartments which do not offer a Ph.D. degree. The maximum award is \$6500 annually for 2 years And last, a special starter grant program is available loi. beginning faculty investigators. These greats consist of The second secon

\$10,000 for 2 years, Collat said, and ere limited to facility mambare in the first 3 years of their tirst faculty appointment. Thasa taculty mambars cannot heve any major support of their rasaarch, excapt for that provided by their instruction

Proposals, accapiad throughout the year, are evaluated by the 24-mamber PRF Advisory Board.

For additional information, contact Collet, The Petroleum Rasearch Fund, American Chemical Society, 1155 t6th Street, N.W., Washington, D.C. 20035 (telephone: 202872-4481).—BTR 83

Geophysical Event

Pagan Voicano, Mariana Islands, Wasiem Pacific Ocean (18.13°N, 145.80°E). All times are local (GMT + 10 h) strong axploalva aruption from North Pagan, the larger of tha two strstovolcanos that form the Pagan volcano conplax, began on May 15. While raporting eirong felt seight ity on tha Island, radio oparator Pedro Cestro suddenly nounced at 0915 that the volcano was erupting. Committee cation was than cut off. An infrared imaga returned from Japanese gaostationary waather eataille at 1000 showed very bright circular cloud about 80 km in diemeter over volcano. The cloud epreed SE at about 70 km/h, and by 1800 its maximum height was actimated at 13.5 km iron satellite imagary. Waakaning of activity was evident on the Imaga returned at 1900, and on the next Image, at 2200, feeding of the eruption cloud had stopped, with the proxmal and of the cloud located about 120 km SE of the work no. No additional activity has been detected on the sales. Imagae, but by 0400 the next morning, remnants of the plume had reached 10°N and 155°E.

Aircraft attampting to land on Pagan Island were prevent ad from doing so by the eruption. At 1235, pilote records much room cloud over the Island and ashfall over its arn and eastern ande. Ash talls were also reported to Agrigan Jeland. Agrigan laisnd, 105 km to the NW. Additional pilot re at 1410 Indicated that the eruption was intenally the cloud had reached more than 7-km aithiuda; Press inlamational reports that aircraft crews flying island at two different (but unspectified); times say to 10.5 and 18 km. Tha U.S. Navy raported layar flows. down the NE and NW lianks into the sea and ebo down the SW flank to wlihin 1 km of the island's view 1/2 km of the airsirip. However, the eircraft instruments measured surface temperature of the 19ve at 200 feet

The Japanese merchant ship Hoyo Man rescuedant persons on Pagah Island early May 18. None of the dants were in urad.

The U.S. Geological Survey sent a three-man leaf the Hawallan Volcano Observatory to Pagan Island the hawallan Volcano Observatory to Pagan Island the hawallan Volcano Observatory to Pagan Island

Information contacts: Frank Smiglaiski, NOAA/National Fovironmentat Satellita Sarvice, Synoptic Analysie Branch. S/OP33, Camp Springs, Maryland 20233.

Gus Telegadaa, Room 617, NOAA/Air Reaourcee Laboratory, Silver Spring, Maryland 20910.
Robert Tilling, U.S. Gaological Survey, Stop 906, Netional Center, Raeton, Virginia 22092.

U.S. Depertment of Datense. United Press International 35

Gaophysicists

Danisi P. Beard was appointed executive director of the Renewabla Natural Resources Foundation, affective May 1 He succeeds Gordon Fredina, who has retired.

Farouk El-Baz, of the Smithsonian'a National Air and Space Museum, was praeanted with the Arab Rapublic of Egypt 'Order of Marit-Firet Class' by Praeldent Anwar Sadat El-Bez, citad for his contributions to space geology, advises Sadat on scientific matters. The presentation was made at the First Scienca Calabration Day in Cairo, on April 14.



Jsmss F. Haya wilt succaed Raymond Siever es chairman of the Department of Gaological Sciences at Hervard University as of July 1. Slavar will ramain on the depert-

Psisr J. Schreuder haa baan appointed e vica praeidant al Gersghty & Miller, Inc., consulting groundwater gaolo-

glets and hydrologists. Ha is the director of the company's Tampa, Fie., and Beton Rouge, Le., officee.



Kenneth M. Wetson was eppointed director of the Marina Physical Laboretory at Scrippe Institution of Oceanography. Ha comea to Scripps ettar eerving tor more than 20 yeare es e profaseor ot physics and researchar al tha University of California at Sarkeley and et the Lewrenca Sarkalay Laboratory. Watson euccaade Fred N. Speiss, who now haads the University of Californie's Instituta of Marina Rasourcas. (Photo courtasy of Scripps)

Geophysicist Obliueries

The following AGU members are recently decaseed: Joseph M. Caldwell, 69, on Decambar 21, 1980. Joined

William M. Chappis, 46, on February 18, 1981. Joined In

James E. Gill, 80, in January, 1981. Life mamber, joined In 1947.

James Gilluly, 84, on Dacamber 31, 1980. Life Fellow, joined in 1934. Nathan M. Nawmerk, 70, on Jenuary 25, 1981. Fallow,

loined in 1962. Anthony J. Polos, 71, In June, 1980. Lila mambar, jolnad in

Ernast Tillotson, 77, on Merch 29, 1981, Lite member, joined in 1947.

Georgs D. Whitmore, 82, on February 9, 1981. Lila mamber, joined in 1948.

New Publications

Early Diagenesis, A Theoretical

Approach R. A. Serner, Princeton Sar. in Geocham, Princaton University Prese, Princation, Naw Jersey, xii + 241 pp., 1980, \$25 (doth), \$9.50 (paper).

Reviewed by Donald L. Graf

In the last 15 years the author has carried out field and laboratory studiae of solid importance to an impressiva variely of areas in sadimentary gaochamistry. This activity, coupled with his lively curiosity about asisbilished theoretical cal concepta in other sciancea that can be brought to bear on geochemical problems, has yielded numerous acientific srticles and an earlier book, in 1971. We encounter most of the theoretical aspects of thas apublications again hera, leavened with additional calculations, mora recent literature citations, and additional insights about applicability obtained during the intervening years of teaching and research.

The transport aquations that form the inacretical core of the book should be familiar to chemical angineers, hydrologists, pstrolaum reservoir angineers, and physical oceanographers. Most of the applications are to ocean aediments. The book is divided into a theoretical section, in which suitable equations are devaloped to describe the physical, blological, and chamical processes ancountered in diagenesis and a discussion of applications to marins sadiments of the continentst margins, deap-aaa eadiments, and nonmarine sediments. Howavar, baceuea much of the literature cited in the latter aection involves tests of mathematical modals, the book la in practice an interplay throughout batwa equations and sets of data, with interspersed excerpts from Peripheral fielda (a.g., aquilibrium tharmodynamics, ion exchanga, reta tawa, microbial reactions, nucleation, and

Even though some useful mathematical simplifications result from considering only the first faw hundred matera of sediment, the problama considered are atill very complex. The common-aansa approach used by Bamar and his fetlow modelmakers is first to defina thaorelical ralationshipa With reasonable but not ultimata precision, than to seek plauelble ways of simplifying these axpressions for particular lar problems, next to accumulate a number of lasta of the simplified axpressiona against particular sate of data, and then to fine-tune back and forth until models are obtained thet, we hope, are uniquely auccaseful in describing a parlcular geochamical anvironment.

The book is a variable ancyclopadia of simplifying assumptions (11 are cited in davaloping one model for calcitim carbonate distribution on the floor of the deep ocean), which releas probleme in comparing results from different Workers with alightly different notions of optimum simplification, The facility with which physical units are radafined is a little unsettling, a.g., because biojurbation is sometimes. lumped within the diffusion term in modeling, it emerges (p. 31) as a category of diffusion. Diapersion is another category ry (p. 31), which should interest hydrologists, who have

mada inolecular diffusion, into chemical dispersion. A blessing of complex natural systems is that they afford

safety velves for models that do not quite til-aregonite dissolving in the middle of your celcile-dissolution study area, ions poisoning the surface of your mineral so that it doesn't tollow en ideal rate law in dissolving (certainty a demonstratad effect in soma systeme). One could, finally, list soma mieleeding stataments in the highly condensed summarlas ebout paripharel sciantific araas.

Howevar, nona of thesa concerns does serious demaga to the centrel bueinase of modelmaking. Recent afforts that have been ebla to use savaral diffarant kinds of meesuremants era particuleriy impressive, a.g., Allar's lataral-diffusion model for pradicting ammonia distributon in the bioturbated zone and Emarson end Widmar'e treelmant of vivianita pradpitation in Leke Greifeneea sedimenie. The contributions of stabla- and redioectiva-isotopic maesuramente are undarrepresented.

This is a sprightly tour through the library and computer room of a country manor where the air is tilled with the music of Revel and with jests about eadimentologists end whelas. Take the lour by all means, and come back again eftar tha new wings are built.

Donsid L. Graf is e mamber of the Department of Geology of the University of Illinois at Urbane-Champaign.

Light Scattering by Irregularly Shaped Particles

D. W. Schuerman (Ed.), Planum, New York, x + 334 pp.,

Reviewed by E. Raschke

This book contains the text of two infroductory papere and axtended abstracts of 35 contributed papara which ware presented during the International Workshop on Light Scattering by Irregularly Shapad Particles (June 5-7, 1979, Stala University of New York et Albany, New York). The purposa of this workshop was to review the state of underatanding and the modaling of the scattering of alectromagnatio radiation by irregularly ehaped particles and to compare it with the first-order solutions which usually are based on equivalent apherical particles.

The field of application is extremely wide. It reaches from interpretations of stellar atmospheres, interplanatary dusts, and atmospherio serosole to the observation of plankton and other auspanded materials in the oceans with remote

eenaing methods The papers of Ihla workshop did not cover all aubjects. In

groups

the infroduction, D. Deirmendlan, a meteorologist, lavored the empirical approach (i.e. in eltu measurements and ad-Justmente to equivalent particles). J. Majo Greenberg, however, recommended extensive basic research of the physical processes involved in scattering of light by irregularly chaped particles; thus, the particle ahape must be known and remote sensing ischniques should use all means to axpidit the information content carried by the scattered light. The other 35 papers have been gathered into 8 sub-

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1. User naads: In tour pepers era discussed the remote sansing of ica clouds, lidar visibility maasurements and saveral epplicationa. Hera, no contribution has been mada trom ocaanography and astronomy.

2. Particla descriptions: Five pepers describe axhaustivaly tha shape of reindrops end ice crystals, and of aerosols from venous ragions. Hara, again, the subject should hava baan extended to the other tields of applications, ocaanography, and estronomy.

3. Theoretical methoda: Fourtaen papars discuss various ways to compute the scattering by particles of verious shapas. Atl contributions cover the subject in great depth, allowing the reader to gain an overview.

4. Experimental mathods: Tan papers were prasantal during this session. In savarat of them, microwave analog axperiments are described, where the extinction of elnola 'enalog' particlas ia directly measured. The methodology of in attu meesuremants (i.a., maasuremenia of tha extinction propartiae of a 'volume of air') has not changed, but the technology has improved considerably. Almost all authore recommended without detalled discussion that measurements be made of as many components of the scattering matrix as possible. This chaptar alone deale with the scattaring by biological particlas.

5. Invareion and information content: Only two papers were devoted to this subject, aince evan for aimplar problama of acallaring by pure spharical particles it is yet relalively unaxplored. In one paper the size of the acatterar le inferred from polarization measurements, an attractive tool which is seldom used. In the other paper a comparison is made between irregularly shaped and spherical particles, using laser and direct aofar radiation measurements. The conclueion is that nonspherical particles in the etmosphere may be considered ee equivalent spheres without serious

Although many abetracte ere rethar short and contain only limited information, this book can be considered as en extremely halpful toot for all those recearch groups and individuala who are angaged in ramole sensing of particla properties and quantities, either when the particles are imbedded in another medium (geaes or water) or entirely free in deep epaqa. I recommend open publications of such proceedings, because it allows the worldwide community to participata in discussions of extreme importance to their research. Expected future restrictions on frevet tunds will even force such means of scientific communications. A paperback version would agem edequate and less expensive than this book.

The organizers of this meeting should be ancouraged to attempi another ona, but it should include a much widerfield of scientific research and broader international participation than they could asaemble at this workshop.

E. Reschke is with the institute for Geophysik and Meteorolog, University of Cologne, Köln, Weet Germany."

Paul G. Richards Columbia University

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Research Seismologiet/Solid Earth Gaophysise. ENSCO, Inc. in Springheld, Virginia is seeking e Program Manageri Research Sesmologiet to support on expanding program in solid settin geo-physics. Research areas will include: seismic network data processing associated with the detection identification and location of natural and main-made seismic sources: earthquake characterization and source mechanism studies; explosion source char-acterization; and empirical studies using near field and lar field seismic data. Experience in theoretica and observational seismology at regional and tele-seismic distances, is highly desirable. Expanence. in digital time series analysis is destrable. Ph.D. In seismology is highly degrable, however, M.S. level with experience in sarthquaks and explosion seismology will be considered. Salary and behelitis are extremely compelitive. Resumes along with eatery requirements should be submitted to the Personnel Department at the address below, Attention Code SAS, ENSCO, Inc., 5408-A Port Royal Road, Opringfield, VA 22:151.

Equal employment opportunity/AAP.

Sedimentologist or Sadimentary Patrolo-gist/University of Celifornie, Senta Serbsva. Applications are invited for a tenura track ap-PM. Applications are invited for a senure track appointment in soit rock geology to be filled in 1981—82. Rank dependent on quolifications and expenence but praference will be given to the assistant professor level. Applicant about normally have e Ph O. and strong field-orientation and quentitative background. The candidate will be expected to develop a strong research program in cleatic sedimentation as related to beein anelyses. The candidate will also be expected to teach at hoth underdata will also be expected to teach at both undergraduate end graduete levels and interect with students and tacuity of the department, particularly in the general areas of clastic diagenests, volcanic processes, paleomagnetics, as well as field geolo-gy. Addrilonal duties may include teaching physical

geology and summer tield geology.

Please send resume, other documentation of abilities, end four letters of recommandation by August 31, 1981 to Dr. Arthur G. Sylvester, Chalman, Department of Geological Sciences, University of California, Santa Baibers, CA 93106. Telephone

The University of California is an affirmative action equal opportunity employer.

Postdootoral/Research Associata Posilione, The Johne Hopkine University, Applied Physics Laboratory, Positions are systiable for studies of magnetospheric-ionos pling. hydromagnelic weves, and plasma instabilities in the ionosphere and magnetosphere. The selected candidates will participate in the analysis and interpretation of data from spacecraft and council has and salars as well as to the council has and salars as well as to the council has and salars as well as to the council has and salars as well as to the council has and salars as well as to the council has and salars as well as to the council has and salars as well as to the council has and salars as well as to the council has an all as to the council has a salars as well as to the council has a salar as th ground-based radars as well as in the develop and implementation of new ground-based and spacecreft studies. Positions are for one year and are renewable. Tenure may begin at any lime through September 1, 1981. Applications should be addressed to Mr. Steven F. Sayre, Dept. AQI-15, The Johns Hoplons University, Applied Physics Laboratory, Johns Hopkins Road, Laurel, MO. 20820.

An equal opportunity smployer, m/l,

Physical Oceanographer. The Pacific OCS Office, Bureau of Land Management, is eseking quelified candideles for a stall oceanographer to supervise contracted mistine emirphmental research. The primary areas of research will be physical oceanography and metaorology. Duties include serving as a contracting officer; authorized representative, developing blucky plans and work statements and advising management on matters within the candidate's area of expertise. Grade level; 38 9/11/12, salary \$18,565-28,951; Glind a current/SF 171 by Juhre 6, 1981 to Administrative Officer; Bureau of Litrid Menagement. (\$10,00/15x11 SLIF) 1982, 200, Los Angeles, CA 90017; Formore information cell 213-688/120.

Mineratogy end Patrology. Applications are invited for a laculty position at Weeber State College, effective September 1981. This is a permanent laculty position with renk, ealery, and tenure lack status determined by qualifications. Responsibilities invited by present the control of the co buildes include teaching undergradueta courses in bilities include leaching undergradueta courses in mineralogy, peliology, end geochemietry and some combination of mineral deposite, structurel geology and introductory geology. Ph.D. preferred. WSC is a large (10,000 students) undergradueta college with a strong geology program graduating about 10-15 majors per year. The college is situated in northern Liteh at the boundary between the Flocky Mountain and Great Basin Provinces and adjacent to the Overthrust Selt. The Oepartmant is well squipped to fletd-oriented teaching and research. The closing date for applications is July 1, 1981. Applications, including evidence of teaching proticiency and the nemes of three relatences should dency and the nemae of three relarances should be sent to S. R. Ash, Chairmen, Oepertrant of Geology/Geography, Weeber Steta College, 3750 Harrison Givd., Ogden, Utah 84408. An aqual opportunity/affirmetive action amployer,

search Salsmologiet. The Alexandria Leboratories of Teledyne Geotech Invitee applications from Ph.D.-level salamologists to work on probleme related to the comprehensive and threshold test ban treaty negotiations. Applicants should have beckground to see the background in such topics as theoretical asismology, saismic data snalysis, saismic data gethering, advanced eclentific computing, and computer systems. To apply please send your resume to Jaan Hill, Pesonnsi Department, Tsiedyna Geolech, 314 Montgomary Street, Alexandrie, Virginie 22314. An equal opportunity employer.

Visiting Lecturer in Geophysics. Geology Department seeks one year visiting tenturer 1981—82 to teach exploration geophysics and easiel with operation of earthquake taborstory (includes WWSBN Station). Require Ph.O. or nearly completed Ph.D. Apply to the Geology Department, University of Montana, Missoula, MT 59812. Deadline August 1, 1981. Telephone (406) 243-2341. EEO/AA employar.

Arizona State University, Department of Chemietry. Visiting professor, 1982–83 acceleration year or part thereof. We seek a person or persons with established research programs if geochemies by white acceptance of the person o



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asserth in oceanography. Investigation of ic composition of neodymum and rere adarcae in see water end sediments is carried forward. The mechanism oil into ass water will be studied. The invitorial water messes is set in ordinary to the composition of the properties of the properties of the composition of the properties of the composition of the properties of the composition of the properties of t

UNOLS Executive Secretary

The University-Notional Oceanographic Laboratory System (UNOLS) is soliditing applications for on Executive Secretary, UNOLS is an organization of ocademic institutions for the coordination and planning af accongraphic facilities, chiefly research vessels. The Executive Secretary administers the functions of UNOLS and heads the UNOLS Office which is located of and hasted by a Member laboratory. New office location is now pending. Institutions which have signified an intention to propose hosting the office

University of Delaware

The Johns Hopkins University, Chesopeoke Boy Institute Lamont-Doherty Geological Observatory of Columbia University University of Southern Cotifornio. Institute for Marine and Coastal Studies University of Washington

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It is anticipated that proposing institutions will negatiote with one at more applicants to become a port of their proposal, and selection will be based, in port, on the qualifications of the successful applicant who will became an employee of the host institution. Required qualifications include experience In accomparable research and knowledge of research ship operations. Salary is negotiable depending on professional qualifications. Deadline for opplications is July 31, 1981.

For further information, contact:

UNOLS Office Box 54P

Woods Hole Oceanographic Institution Woods Hole, MA 02543 (617) 548-1400, Ext. 2352

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Physical Oceanographer: Memorial University of Newfoundland. Memorial University undend in St. John's seeks to illi two faculty positions in physical oceanography. One po-sition is in ocean dynamics and the other is in theoretical oceanography. Interest end experience in carrying out field programs is dealreble. Candidates to both positions should hold a Ph.O. in physical

oceanography, or a closely related field (e.g. fluid mechanics). The program in physical oceanography at Memorial University is new and offers the successful applicant an opportunity to participate in the develop-ment of this field in a hontlet eree, Memoriel Uni-versity is located in St. John's, Newloundland, which is rapidly becoming a centra of ocean studies related to fisheries and offshore hydrocarbon deval-

opment in Eastern Canade. Salary will be commensurate with experience

plications, including curriculum vitae and the names of three relaress, are to be submilled to:

Department of Physics Memorial University of Newfoundland St. John's, Newfoundland

Faculty Position/University of Alaska, Feir-banks. Applications era invited for a tenure track aculty position in economic geology in the Geology Geophysics Program to teech undergraduate and graduate courses in ora deposite, minaratogy.

d exploration geology.

Applications should have demonstrained precitations and deexperience in mineral exploration, regional and de-tained geologic mapping as well as a commitment to research in the geneals of oro deposits. The candidate will be expected to pursue a vigorous gradu-12 leaching and research program in economic 9000gy with atudents primarily oriented toward ca-

reers in the mineral industry.
Preference will be given to individuals with expedence in arctic or auberctic minerals research and a record of close collaboration with the mineral in-

dustry. Academic rank and selary commencer in-dustry. Academic rank and selary commencerata with experience. Ph.O. sequired.

Send resume and three letters of reference Ol-lector, Division of Geoactences, University of Alas-ks, Farbanks, Aleeka 99701. Applications will be accepted until time so, 1001, or until fatled. ccepted until June 30, 1981, or until filled.

The University of Aleske le an equal opportunity/

Sedimentologiet-Sedimentery Potrogra-pher/Dhio State University. The department of Geology and Mineralogy Invites applications for a tenure track leculty position in sedimentology-Salary and rank competitive and commensuret

with experience.

Applicants should send recumes and names of at least three referees or eddrage inquiries for further information to Peter-N. Webb, Cept. of Declopy and Minerelogy, The Ohio State University, 125 South Oval Mell, Columbus, Ohio 43210, Closing date is July I, 1981.

The Ohio State University is an equal opportuni-

Selemetogy, Research associats position anticipated [Septembet 1, 1881), jalemetry monitoring project in Virginia. Problems focus on selemicity and neotectonics in the state. Prefer M.S. geophysicist with theste in observational selemotogy, but others considered. Applications, transcripts and two letters of recommendation to; Dr. G. A. Bollinger, Selemotogical Observatory, VPASIJ. Blacksburg. Balamelogical Observatory, VPI&SU, Blacksburg, Virginie 24081. Observatory to receipt of applications

s August 1, 1981. VPI&SU is en equel opportunity/afirmative action

Research Fettow/Sadimentery Gacchamis-try. The Austrelian National University invites ap-plications for appointment as research fellow in addimentary geochamistry, Research School of eadimentery geochemistry, Research School of Earth Sciences. The School has a well equipped traco element laboratory, including an MS7 Spark Rounes Mass Spectrometer, with eccess to electron microprobe and XRO facilities. The successful epolicant should hold a Ph.D. de-

gree and have a good background in geology, geo-chemistry, enelytical chemistry, sedimentology and Pre Cambrien geology and should have experience in the use of the above analytical techniques. He or ahe will be expected to perticipate in joint research projects dealing with the use of trace element geochemistry in elucideting the composition and evolution of the Earth's cruet through studies of sedimentary rock sequences. In addition, applicants are invited to submit re-

search proposes detailing the general research directions and specific projects which they would wish to pursue. Further information concerning the

position can be obtained directly from Dr. S. R.

Applicants should submit a dolarled curriculum viae, a publications list and the names and address es of three referees.

thee yeers in the first instance with the possibility of extension to five years. Selery rongo: \$418132 to \$424972 per annum (\$41 = \$US1.14). Superan-

ment costs.

The University reserves the right not to make en appointment or to make en appointment by invitetion at eny time.

plications should be eant to The Registral. The Austrelian National University, PO 80x 4, CANSERRA, ACT 2800, AUSTRALIA by 3 AU-

Blogeochemist or Organic Geochemiet.
Research assistant professor with interest in organic metter cycling in coastal sectment systems, as part of interdisciplinery group. Academic yeer appointment with opportunity for renewel Resume, names of three references, and letter of research interests. by July 1 to L. Meyer, Ire C. Dailing Center, Univer-elty of Meins at Orono, Walpole, Maine 04573. Equal opportunity/effirmalive action employer.

Cruatel Selemology: Princaton Univer-eity. Candidates with an intersel in eny of the fol-lowing sin Invited to apply for research staff ap-

1. Morino soismic data analysis and struc

tue of oceans and ocean mergins.

2. Narrow and wide angle reflection seismology applied to confinential crustal geology.

3. Wove propagation theory and techniques et eaismic data analysis.

Princeton University has an ongoing program for the creative reanalysis of existing multichannel re-liculon data—such as COCORP and USGS offshore date. Special projects are undartaken from time to time to collect floid data in critical erses or to test new methods of date collection and enalysis. A high performance 32 bit minicomputer system for deta enalysis and theoretical work is to be installed

Applicants should send curriculum vitae and e list of three releionces to:

Robert A. Phinney

Department of Geological and Geophysical Princeton University Princeton, NJ 0854

Or Inquira: 609-452-4118. Data of spoointment and setery ere negotieble. Princeton University is an equal opportunity om-

Consejo Nacional de Investigaciones Cientificas y Técnicas

CHIEF OCEANOGRAPHER

A postdoctorel scientist with several years experience in physical oceanography is required at IADO (instituto Argentino de Oceanogrefle), a joint institution of the Consejo Nacional de Investigaclones Cientilicas Y Técnicas (National Research Council), the Universidad dei Sur, Bahla Biance, end the Armada Argentina (Argentine Navy).

The explicent, in eddition to research and postgraduate teeching in his own field, will also be responsible for the planning, coordination, end supervision of activities in other branches of oceanogra-

The position is under the auspices of a joint program of the Consejo Necional de Investigaciones Científicas y Técnicas (CONI-CÉT) and the Interamerican Development Bank (IDB). It will be inilielly of medium durellon, and is renewable.

It will be located et Behle Blance. Salary end fringe benefits eccording to qualification. Knowledge of Spanish language will be considered en advantage. For consultations or submitting applications, contect:

Señor Presidente dei Conselo Nacional de Investigaciones Cientificas y Técnicas Avda, Rivadavia 1917 (1033) Buenas Aires, Argentina.

Applications should include complete academic end professional beckground elong with a list of publications es well as names and addresses of three references.

AGU

New Member Sponsors

One hundred sixty-six members were elected between March 31 and April 30, 1981. The AGU members who sponsored them ere listed below. Earlier lists were published Merch 24 end April 28.

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Meetings

Applied Glaciology Symposium

The International Gleclology Society has stated fits eacond meeting on the applied aspecta of snow and ice research for August 23–27, 1982, at the Cold Regione Research and Engineering Laboratory in Hanover, New
Hampshire. This Second Symposium on Applied Glaciology
will include technical sessions on the engineering problems
of floating ice; engineering probleme of ground ice; icabergs and glaciers; properties and behavior of snow and
ice; snow ramoval and control; evaluanche control end snow
pressure; ica accretion; and modeling techniques in applied
glaciology.

For additional information, contact the Secretary General, international Glaciological Society, Lenslield Road, Cambridge CB2 1ER, United Kingdom.

Constal Engineering Conference

The 18th Intomational Conlarence on Coastal Engineer-Ing, will be hald Novembar 14-19, 1982, in Cape Town, Ropublic of South Africa.

Topics to be covered at the conference include wind current and wave action; tides and fong waves; sedimentary processes end coastal morphology; estuary and intel behavior; coastol structures and recreational tacilities; ship motions end herbor entrence design; oceen outlail design and construction; and environmental aspects of coastal enginoering.

Five copias of n synopsie (not to axceed two pages) of papers proposed for the conference should be sent to Billy L. Edga. Secretery, Coastal Engineering Research Council, Daparimant of Civil Engineering, Clemson University, Clemson, SC 2963t. Deadline is October 31, 1981.

Underwater Mining Institute

The 12th Underweler Mining Institute is schaduled for Octobar 20–22 in Madison, Wisconein. The program will Include prasentations on mineralogy of marine sulfide depoetis; tectonic selfing for spreading center sulfide deposite; seafloor sulfides in the Gelspagos and other Pacific erees; new developments in aoutheast Asle offshore tin operations; geophyaicst techniquae for finding underweter copper lodes; new geochemical fechniquee for marine minerels exploretion; changes in the international mining trade of relevence for merine mining; and the Impact of sea grent minerals research on industry. The program will also include lours to local research laboratories.

For registration information, contact Gregory Hedden, Sae Grent Advisory Services, University of Wisconson, 1815 University Avenue, Madison, WI 53708 (telephone: 608/262-0644).

For technical program information, contact J. Robert Moore, Marine Science Institute, University of Texas, P.O. Box 7999, University Stallon, Austin, TX 78712 (tetephona: 512/471-4816).

AGU Midwest Meeting

September 17-18 Minneapolis, Minnesota

Abstract Deadine: July 1 Convenor: V. Rama Murthy

Papers and postars originating in or pertaining to the region are solicited for the tollowing special seseions:

Muntle structure and dynamics. Conlact Geoffray Davies or Clem Chase.

Rock weter interactions: Hydrothermal processes end metallogenesis. Contact William Seyfried.

Precambrian crustel evolution of the North American continent. Contact Paul Walblen.

Geomagnetism and paleomagnetism. Contact Subir Banerjee.

Hydrology in the mid-continentel U.S. Contact H. O. Plannkuch or E. C. Alexandar, Jr.

Abs/recte

Use alendard AGU format (saa paga 20 of January 13 Eos) and send original and two copies of ebstracts to AGU Midweet Meeting, 2000 Florida Avenue, N.W., Washington, D.C. 20009. Abstracts will be published in Eos, with a substantive meeting report after the meeting. There will be no abstract charge.

Aquifer Protection Policies

A apecial program entitled 'Effecta ot New Aquifer Protection Regulatione and Policies on Ground Water Managament' will be held at the American Society of Civil Engineers' Spring Convention and Exhibit during the week of April 19, 1982, in Les Vagae, Nevada. The progrem la aponeored by the Hydraulic Division's Committae on Ground Water Hydrology and by the Environmental Engineering Division's Committee on Hazardoue Weate Mensgement.

A cell for papers has been lasted for the following topics: review of regulatory activity, future protection regulations, and policiea; groundwater quality monitoring; design of well networks; groundwater attidies stemming from regulations, including remedial measures; and ongoing and needed research. Reaearch topics should address polition sources, transport and fate of pollutants, methode of detection, and aquifer rehabilitation.

Geophysiciete interested in preaenting e peper ahould sand a one-pege ebstrsci to Richard J. Schicht, Illinola Stale Wster Survey, 605 East Springflald Avenue, P.O. Box 5050, Station A, Champeign, IL 81820 (telephone: 217/333-2594). Deadline is July 31. 38

Workshop on Remote Measurement of Underwater Parameters

Thie workshop was held at Bolkesjo, Norway, Ociober 30 to November 1, 1980. If wea erranged by the Royal Norwegien Council for Scientific end Industrial Research, Space Activity Division; institute of Gaophysicel Research, Univarsity of Bargen; and Office of Navel Research, Arlington, Virginia. It was eponsored by the Royal Norwegien Council for Scientific and Industrial Research, the North Atlantic Treety Organization, and the Office of Navel Research.

One may conclude from the meeting that the idea that it may be possible to determine any subsurface variables of the oceen by remote eensing le attractive in principle, but realizeble now, in a severely limited manner, and still possibla ot advancement. Sound weves are now used for tracking SOFAR licels to msp out deep and mid-level currente, end ecouefic tomography offars possibilities that ere now being explored in the field, with the tirst tantative resulte now being reported. Acouetic tomogrephy meesures a combination of velocity end sound speed fields over tha water column, end the data cen be interpreted to give meen variables and a number of integral measurea of water properties ee well es elatistical maasuree ot the field of veriebles. The upper mixed layer is not so well sempled by ecoustic tomography, so for the upper leyer, one will have to rely upon other methods. In saltwater, electromegnetic waves cannot be used profitebly; for brackleh or fresh welar overlying ealt water, radar monopulse methods offer some promise. Such methoda are in routine use for ice proakee and rivere, and extension to estueries may prove useful and practical.

Setellite Interrogation of drifters, and shore stetion tracking of drifting buoys are other methods of obtaining information about the ocean without having to go there each time one wents information.

Among the active mathods of seneing variables in the upper ocean are ground wave and ionospheric ecaffer reder. The ground wave radar method, on a axample of which is CODAR, when used from shore, can aense the current flaid in the upper 1/2 meter of the oceen with a special resolution of 1.5 km² and 0.10 m/s. While a few examples were given of synthetic sperture reder (SAR) signetures in SEASAT-SAR dats, the processing algorithm was not described in sufficient detail to enable one to make any judgament about the method, although in principle it should be possible to infer current along one direction from Doppler-shifted reflectione. The SAR data also show a strong correlation between bathymetry and sea surface roughness. As at previous workshops where these data have been presented, there was little, if any, enalysis given of the dynemics of the processes. The active optical methoda, using laser light sources, take advantage of the joliowing effects; the Rayleigh scattering broadana the spectral width, and the broadening is temperature dependent. Thus, one may be able to measure temperature by observing the raffected light, from pulsed, range-gated lasers.

Next comee Rsmsn backscatter tor meesurements of 83linity, temperature, and other variables, end then comes Brillouin scattering to senes sound valocity. When a very intense isser algnal hits the water, if will also heat it and generate an acoustic signal. The reflection of the acoustic algnal back to the surface (by density structures) will in time generate a measurable surface signature. One can use lie for depth sounding from eirplanes and, utilimalely, from even mora remote platforme. The combination of possible tlea, although few of them are now at a elags ready for routine practical use, suggests that one should follow developments closely. The methods, so tar, seem to be mainly useful in the upper 50 m of the ocean but may some day be extended to several times that depth. This will tell us very little about the deeper water column. But the possibility of obtaining eynoptic data, even in the upper few melers, esems interesting. The technology needs to be worked out and the oceanographic community need not yet hold like collective breath and sit around and wait, but the new methods may be upon us in a tew years. The scrive and passive remote seneing of water properties has, of course, elso baen axtended to sensing of biological properties. Here the workshop contained a very interssling as of papera on algorithma and the inverse problem and an exampla of application of color measurement to mud flat and flat si flat propertiee.

The first paper was by N. K. Hojerslev, who showed that different regions of the ocean have sufficiently different plankton-related color that a universel signifilm for interpreting color in terms of biological measures will have sedous shortcomings. The next papar, by J. Fischer and H. Grasal, who had examined the problem of remote sensing of particulates, found that the problem of determining particulate matter variables from color observationa was not wall conditioned and that the matrix really had only two lineerly independent characteristic vectors. The tentstivs conclueion of this listener to these two papers was that below one can use color to determine biological variables, one needs to introduce some Information about local biological properties as e constraint on the inversion process. This means that one needs biologists to help with the interpretation; one cannot find a wey where the technology system and the computer can do it all by themselves. This should not be e source of wonder because biology is a nonlivial branch of science and cannot be left to eutomation. One has to develop e certain judgement end expertise below one can produce ussful results.

The Coastel Zons Color Scanner provides useful information for biologists, but the information from the intensity of color bands cannot be used blindly, it has to be intensity of color bands cannot be used blindly, it has to be intensity of color bands cannot be used blindly, it has to be intensity of the use of knowledge about local blology as a constreint on the invarsion process. An example of how to incorporate local knowledge in an invarsion problem was given by Prober, Bahr, and Dennert-Muller, who interpreted the LANDSAT images from different channels, in terms of ideal tiet classes, including dry sand, well mud, and others by using 'training fields' and in situ establishment of field characteristics. The use of these freining fields introduced the local constraint on the invarsion process and made it possible to classify a large region from LANDSAT data attentield work in a limited area that covered the important classes of fists.

Thia is apparently the direction in which one has to seek methods for interpreting upper ocean color. Also, no doubt, the earne method can be used with active aensors, where one senses the color quality of reflection of leser lights from different dapthe, including fluorescence effects.

While some of the methoda seemed kind of far from practicel resilization in the neer future, there is repid technology devalopment under way.

The workshop was informetive for the perticipants, and the sober asassements provided by the working groups showed that one cannot diemise remote aensing techniques out of hend, that the technologists need to encounter eclentiate to learn what one should look for, and it showed how one may adjoin specialist knowledge to remote sensing data. In that asnae the workshop was sducational, resiletic, and productive of sober evaluations of methods. An abstract volume will be available shortly from the Royal Norweglan Council for Scientific and Industrial Research, Space Activity Division, P.O. Box 309, Blindern, Gsustadallen 30 D, Osio, 3, Norwey.

Thie meeting report wea prepared end submitted by Eff.
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June 1-4 First JECSS Workshop Tokyo, Japan. Sponeor, Teukuba University. (Takashi Ichiye, Oept. of Oceanography, Texas A&M University, College Station, TX 77843.)

June 1-5 Second International Symposium on triarital Technology for Surveying and Geodasy, Bsnff, Caneda. Bponeore, AGU, Canadian Inetiliute of Surveying, Univ. of Celgery. (Kleue-Peter Schwarz, ISS Symposium 1981, Division of Surveying Englineering, Univ. of Celgary, Celgary, Alberta T2N 1N4 Cenade.)
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June 22–28 International Sympoelum on Erosion and Sediment Transport Maaeurement, Florence, Italy. Sponeore, IAHS, International Commitesion on Continental Erosion, National Research Council of Itely. (P. Tecconi, Secretary of the Organizing Committee, fetituo di Ingegnaria Civila Vie S. Marta, 3 50139 Firenza, Italy.) June 23–28 Seventh International Symposium on the Machina Procaeeing of Remotely-Senead Oata, Wast Lafayette, Ind. Sponsor, Laboratory for Applicatione of Remote Sensing, Purdua Univ. (D. B. Mortison, Purdua Univ. J.ARS, 1220 Pottar Or., Weel Lateyette, IN 47908.)

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SB7 Canade.)
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Edinburgh EH9 3LA United Kingdom.)

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Leeton, Institute of Geological Sciences,

Kingston, RI 02881.)

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Pastacotore L Research Associate Posine Hopkins University, Appiled Physice Lebore tory. Positions are svall-able for studies of magnatospheric lonespheric coupling, hydromagnetic wayas, and plesmo ping, nyaromagneric wayas, and presmo instabilities in the lonosphere end megnotosphere. The eelected candidates will participate in the enal-ysis and interpretelion of data from spacecreft and ground-based radars as well as in the devel and implementation of new ground-based and spacecroft studies. Positions are to one year and are temperature. Tenuto most beginned to the property to the property of the prop spacecrost studios. Positions ers for one year and are isnowable. Tenuro may begin at any lime through Soptember 1, 1921. Applications should be addressed to Mr. Stoven F. Sayra, Dopt. AOI-15, The Johne Hopkins University, Applied Physics Laboratory. Johns I lopkins Road, Laurel, MO 20820

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Physical Oceanographer. The Pacific OCS Office. Burseu of Lend Managemoni, is sasking quoi fied candidates for a stat coanographer is superise contracted marine environmental research. The primary areas of research will be physsearch. The primary areas of research will be physical oceanography and meleorology. Outres include serving as a contracting officer's euihorized representative, developing study plans and work stolements and advising management on maltero within the candidate's area of expertise. Grade tevel: OS: 9.11.12, salary \$18,685-26,951. Send a current 2F171 by June 6, 1981 to Administrative Officer, Bureau of Land Management, 1340 W. Sixth SI., Rm 200, Los Angeles, CA 900 t 7. For more information, call 213-688-7120.

Minerelogy and Petrology. Applications are invited for a feculty position of Weeber Otate Col-lege, affective September 1981. This is a parmalegs, effective September 1981. This is a perma-noni faculty position with rank, selery, and tenure frack status datermined by qualifications. Responsi-bilities include teaching undergraduate courses in minoretogy, patrology, and gaochemistry and some combinetion of mineral deposits, etructural geology and introductory geology. Ph.O. preferred. WSC is a lorge (10,000 students) undergraduate college with a strong peology program graduating about e lorge (10,000 studente) undergreduete college with a sirong geology progrem gredueting about 10–15 majors per yeer. The college le etilusted in northarn Uteh et the boundary betwean the Rocky Mountain and Oreal Geolo Provinces and edjecent to the Overthrust Gelt. The Department is well equipped for lietd-oriented leaching and research. The closing dale for epplications is July 1, 1981. Applications, including evidence of leaching profit. Applications, including evidence of leaching profi-ciency and the names of three references should be sent to S. R. Ash, Chelman, Oepartment of Geology/Geography, Weeber State College, 3750 Harrison Skd., Ogden, Utah 84408. An equal opportunity/affirmative action employer,

Research Seismologist. The Alexendrie Lebfrom Ph.O. level seismologists to work on probleme rolled to the comprehensive and threshold teel ban treaty negotiations. Applicants chould have background in each topice as theoretical estamoto-gy, estamic data enalysis, seismic date gethering, advenced scientific computing, and computer eys-tams. To sonly classes send your resume to lean advenced scientific computing, end computer eye-tems. To apply please sand your resume to Jean Hill, Pesonnel Department, Teledyne Geotech, 314 Montgomery Street, Alexandria, Virginie 22314. An equal opportunity employer

Visiting Lecturer in Geophysics. Geology Ospartment seeks one year visiting lecturer 1981—82 to teach exploration geophysics and essist with operation of earthquake laboratory (Includes WWSON Otation). Require Ph.O. or nearly completed Ph.O. Apply to the Geology Department, University of Montena, Missoule, MT 59812. Osadiina August 1, 1981. Telephona (406) 243-2341.

Arizona State University, Department of Chemistry. Visiting professor, 1982–83 academic year or part thereol. We saek a person or persone with established research programs in geochemistry, mineralogy, petrology, and/or solid state chemistry to leach advanced special topics course(s), interact with loculty and cludents, and pursus own leach advanced special lopics course(e), in-leach with loculty and eludente, and pursus own respect. May be an excellent sabbetical opportuni-ty for established sciential. Contact: A. Navrotsky. Oppartment of Chemistry, Artzona étate University, An AA/EO employer.

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Raseeroh Poeitien in Chamical Oceanography. California institute of Technology. Division of ological and Plenetery Sciences. The position of esearch lellow to being offered at Caltech for te esarch in oceanography. Investigation of the jedio-to composition of neodymium and rare earth abits. dencee in sea water and sediments is now being carried forward. The mechanism of injection of REE into see weter will be studied. The differences in Al. Nd/¹⁴Nd in verious water maeass [Piepgras 6 al. Earth and Planat. Gd. Lett. 45, 223-236 and Plepgras and Wasserburg, Earth end Planet. Sci. Lett 50, 128-196 (1990)] la now being carried for ward as an exploratory venture in order to determine the origin and chemical behavior of REE in the ocean and the potential use of ""Md" Nd as a tracer. The laboratory facilities for eample prepara tion and analysis are fully lunctional and will be avallable. Applicants should have training in ocean ogrephy end a good parepective on general physi-

Send reaume and references to Professor G. J. Wasserburg, Lunetto Asylum, Cellionia Institute di Technology, Pasadana, CA 91125. Caltech is an equal opportunity/effirmalive action

UNOLS Executive Secretary

The University-Notional Oceanographic Laboratory System (UNOLS) is soliciting applications for an Executive Secretory, UNOLS is an organization of ocademic institutions for the coordination and planning of oceanagraphic facilities, chiefly research vessels. The Executive Secretary administers the functions of UNOLS and heads the UNOLS Office which is located of and hosted by a Member laboratory. New office location is now pending, institutions which have signified on Intention to propose hosting the office

University of Deloware

The Johns Hopkins University, Chesopeoke Boy Institute Lamont-Doherty Geological Observatory of Columbia University University of Southern Collifornio, Institute for Marine and Coostal Studies University of Woshington

Woods Hole Oceanographic Institution

It is anticipated that proposing institutions will negatiate with one or more applicants to become a port of their proposal, and selection will be based. In port, on the qualifications of the successful applicant who will become an employee of the host institution. Required qualifications include experience in oceonographic research and knowledge of research ship operations. Salary is negotiable depending on professional qualifications. Deadline for opplications is July 31, 1981.

For further information, contact:

UNOLS Office Box 54P

Woods Hole Oceanographic Institution Woods Hole, MA 02543 (617) 548-1400, Ext. 2352

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Physical Oceanographer: Mamorial University of Newfoundland. Memorial University of Newfoundland in St. John's eacks to lift two it of Newfoundland in St. John'e eeeks to HII two faculty positions in physical oceanography. One position is in ocean dynamice and the other is in theoretical oceanography. Interest and experience in carrying out field programe is destrable. Candidetes for both positions should hold a Ph.O. in physical oceanography, or a closely related field (e.g. Ituld manhalist).

The program in physical oceanography at Mamo-rial University is new and offere the successful apment of this iteld in a frontier eree. Memorial Unirereity is located in SI. John'e, Newtoundi which is repidly becoming a centre of ocean eludies releted to fisheries and offehors hydrocarbon develpment in Essiem Cenade.

Salary will be commensurate with experience Applications, including curriculum vitae end the names of three referees, are to be submitted to:

Dapartment of Physics demortal University of Newloundland

Faculty Position/University of Aleske, Feirbanks. Applications are invited for a lenure track lacelty position in economic geology in the Geology-Geophysics Progrem to teach undergredueta and graduate courses in one deposits, mineralogy,

and graduate courses in one deposite, mineralogy, and exploration geology.

Applications should have demonstrated precitical experience in mineral exploration, regional and detailed geologic mapping as well as a commitment to research in the genesis of one deposits. The candidate will be expected to pursue a vigorous graduate forms and applications and applications and applications.

oes will be expected to pursue e vigorous gradu-z's teaching and research progrem in economic geology with studente primarily oriented toward ca-reers in the mineral industry.

Preference will be given to individuale with expe-tence in artic or subsectic minerale research and a record of close collaboration with the mineral in-dustry. Academic and and articles representation dustry. Academic senk and ealary commensurate

with experience. Ph.O. required. Send resume end three lettere of reference Ofredor, Division of Gaocciences, University of Alas-ta, Fairbanks, Alaske 98701. Applications will be

accepted until June 30, 1981, or until lilled.
The University of Aleske is en equel opportunity/

Padimentologiot-Sedimentery Petrogre-pher/Ohio Stete University. The department of Occlegy and Minerclogy invites applications for a lenure track faculty position in codimentology. sedimentary pelrography. The appointment to eval-able from August 1981.

Selery and rank competitive end commensus Applicente ehould send resumes and nemes of et east three referees or eddress inquiries for further Information to Peter-N. Webb, Cept. of Osology and Minerelogy, The Chio State University, 125 South Ovel Mall, Columbus, Ohio 43210. Closing

dete is July 1, 1981. The Ohio State University is an equal opportuni-

Ociemalogy. Research associate position entic-lipated (September 1, 1981), telemetry monitoring project in Virginia. Problems focus on seismicity and neotectonics in the state Pieter M S geophys icist with theeis in observational acomology, but others considered. Applications, transcripts and to letters of recommendation to: Or. O. A. Bollinger. Salemological Observatory, VPI&SU, Gleckaburg. Virginia 24081. Obedine for receipt of application: s Auguel 1, 1881. VP&SU is an equel opportunity/effirmetive ection

Racaeroh Fellow/Sodimentery Oecohemis-try. The Australien National University Invites epelications for appointment as research follow in sedimentary geochemietry, Research School of Earth Sciences. The School has a well equipper ireca element isboretory, including on MS7 Spark Source Mass Spactrometer, with access to electron microprobe and XRO lacilities.

The successful applicant should hold a Ph.O. de-

grea and have e good background in geology, geo-chamistry, analytical chamistry, eadimentology and

chemistry, anelytical charmstry, ecomenitology and Pre Cambrian geology and chould have experience in the use of the above analytical techniques. He or she will be expected to participate in joint research projects dealing with the use of trace ele-ment geochemistry in studiesting the composition and evolution of the Eerth's cruet through studies of

eedimentary rock sequences. In addition, epplicants ere invited to submit research proposale detailing the general research di-rections and opecific projects which they would wish to pursue. Further information concerning the poelition can be obtained directly from Or. S.R.

pplicanto chould submit a delailed curriculum vitaa, e publications list and the names and address.

Appointment as research fellow will be up to three years in the first instance with the possibility of extension to live years. Selecy range: \$A19132 to \$A24972 per ennum (\$A1 = \$US1.14). Suppren-

ment costs.

The University reserves the right not to make en appointment or to make an appointment by invitetion at any time.

Applications should be sent to The Registrar, The Australian National University, PO 90x 4, CANSERRA, ACT 2800, AUSTRALIA by 3 AU-

Biogeochemist or Organio Oecohemiet. Rosearch assistant professor with interact in organic matter cycling in coostel sediment systems, as pert of interdisciplinary group. Academic year appointof interdisciplinary group. Academic year eppoint-ment with opportunity for renewal. Resume, namos of three references, and letter of research interests by July 1 to L. Mayer, Ira C. Darling Center, University of Meine si Orono, Welpola, Meine 04573. Equel opportunity/affirmelive eclion employer.

Cruetel Selemology: Princeton Univeralty. Condidates with an interest in any of the fol-lowing are invited to apply for research elaft sp-

Marine coismic deta anelyalo end struc-

ture of oceane and ocean mergins.

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3. Weve propagation theory and techniques of eatsmic deto analysis.

Princeton University has an ongoing program for the creative rosnelysis of existing multichennol ro-flection date—such as COCORP and USGS ofshore data Special projects are undertaken from time to time to collect field date in critical areas or to test new methods of date collection and analysio. A high performance 32 bit minicomputer system for deta anelysic and theoretical work is to be installed Applicants should send curriculum vitee and a list

of three references to: Robert A Phinney

Oppartment of Geological end Oaophyoical Princeton Univarsit Princolon, NJ 08544 Or Inquire: 609-452-4118

Dato of appointment and salary ero negotieble Princeton University is an equal opportunity om-

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CHIEF OCEANOGRAPHER

A posidocioral scientist with several yeers experience in physical oceenogrephy is required at IADO (Instituto Argentino de Oceanogralia), e joint institution of the Consejo Nacional de Investigaclones Clentilicas Y Técnices (National Research Council), the Universidad del Sur, Bahla Blance, and the Armada Argentina (Argenline Navy).

The applicant, in addition to research and postgraduate leaching in hia own field, will also be responsible for the planning, coordination, and supervision of ectivities in other branches of oceanography at lerge.

The position is under the auspices of a joint program of the Consejo Nacional de Investigaciones Cientílicas y Técnicas (CONI-CET) and the Interamerican Development Bank (IDB). It will be initially of medium duration, and is renewable.

Il will be loceted et Bahia Blanca. Salary and fringe benefils according to qualification. Knowledge of Spanish language will be considered an edvantege. For consultations or submitting applications, contact:

Señor Presidente del Consejo Necional de Investigaciones Cientificas y Técnicas Avde, Rivadavia 1917 (1033) Buenos Aires, Argentina.

Applications ehould include complete academic and professional background along with e liet of publications as well as names end addressea of three references.

AGU

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Ona hundred sixly-six members were slected between March 31 and April 30, 1981. The AGU members who sponsored them ere listed below. Earlier lists were published March 24 end April 28.

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Meetings

Applied Glaciology Symposium

The International Glaciology Society has eleted its second meeting on the epplied espects of snow end ice reeeerch lor August 23-27, 1982, et the Cold Regions Reeearch and Enginsering Laboratory in Hanover, New Hempshire. This Second Symposium on Applied Glaciology will include technical eessions on the engineering problem of floating fce; angineering problems of ground ice; icebergs and gleclers; properties and behavior of snow and ice; snow removal and control; evalenche control and enow pressure; ice eccretion; and modeling techniques in epplied

For additionel informetion, contool the Secretary General, Internolional Glaciological Society, Lansuald Road, Cambridge CB2 1ER, Unlied Kingdom. 6

Coastal Engineering Conference

The 18th Informational Conference on Constal Engineering, will be held November 14-19, 1982, in Cape Town, Ropublic of South Africa.

Topics to be covered at the conference include wind currani end wave action; fides and long waves; aedimentary proceesos and coasial morphology; estuary and inlei behavior; coasial structuros and recreational factities; ehip mollons and horbor ontrance design; ocean outlall design and construction; end environmental aspects of coastel en-

Five copies of a synopsie (not to exceed two pages) of papers proposed for the conference abould be sent to Bitty L. Edge, Secretary, Coastal Engineering Research Council, Department of Civil Engineering. Clemson University. Clemson, SC 29631. Deadline is Oclober 31, 1981. 6

Underwater Mining institute

The 12th Underwater Mining Institute is scheduled for October 20-22 In Madieon, Wisconsin. The program will Include presentations on mineralogy of merine sullide deposits; lectonic setting for epreading center sulfide deposite; eeafloor sultides in the Galapagos end other Pediic arees; new developments in southeast Aete offehore tin operations; geophysical lechniques for finding underweter copper lodes; new geochemical lechniquee for marine minerala exploration; changes in the international mining trade of ratevance to marine mining; and the impact of eee grant minerels research on industry. The progrem will elso include tours to locat research laboratortes.

For registration information, contect Gregory Hedden. Sea Grant Advisory Services, University of Wisconson, 1815 University Avenue, Madison, WI 53706 (telephone: 608/262-0644).

For technical program information, contect J. Robert Moore, Merine Science Institute, University of Texas, P.O. Box 7999, University Station, Austin, TX 78712 (telephone: 512/471-4818). 6.

AGU Midwest Meeting

September 17-18 Minnapolis, Minnesota

Abstract Deadine: July 1 Convenor: V. Rama Murthy

Papars and posters originating in or pertaining to the region are solicited for the following apecial ses-

Mentle structure end dynamics. Contact Geoffray Davias or Clem Chase.

Rock water interections: Hydrotharmal processes and metallogenesis. Contact Willem Seyfrled. Precambrian crustal avolution of the North American continent. Contact Paul Walblen.

Geomagnetism end paleomagnetism. Confact Subir Baneriee.

Hydrology in the mid-continental U.S. Contact H.O. Plannkuch or E.C. Alexandar, Jr.

Abstracts

Usa standard AGU format (eee page 20 of January 13 Eos) and send original and two copies of abelracie lo AGU Midwasi Meeling, 2000 Florida Ave-nue, N.W., Weshington, D.O. 20009. Abstracts will be published in Eos, with e substantive meeting report effor the meeting. There will be no abstract charge

Aquifer Protection Policies

A special program entitled 'Effects of New Aquifer Profection Regulations and Policies on Ground Water Menagement' will be held at the American Society of Civil Enginears' Spring Convention end Exhibit during the week of April 19, 1982, in Las Vegee, Nevada. The progrem le sponsored by the Hydraulic Division's Committee on Ground Water Hydrology and by the Environmental Englneering Division's Commilles on Hazardous Weste Men-

A cell for pepere has been issued for the following topics: review of regulatory activity, future protection regulations, end policiae; groundwater quality monitoring; design of well networks; groundweler afudies stemming from regulations, including remedial measures; end ongoing and needed reeeerch. Reseerch topics should address pollution sources, trenaport and fale of pollutents, methods of detection, end aquifer rehebilifetion.

Geophysicists interested in presenting a paper should send a one-page ebstract to Pichard J. Schicht, Illinois Stele Water Survey, 805 East Springfield Avenue, P.O. Box 5050, Stetlon A, Chempalgn, IL 81820 (telsphone: 217/333-2594). Deedline le July 31. 88

Workshop on Remote Measurement of **Underwater Parameters**

This workshop wae held et Bolkesjø, Norwey. Ociober 30 lo November 1, 1980. It was arranged by the Royal Norweglan Council for Scientilic and Industrial Research, Space Activity Division; inelliute of Geophysicel Research, University of Bargen; end Office of Neval Research, Arlington, Virginie. It was eponsored by the Royal Norwagian Council for Sclantilic and industriel Research, the North Allentic Treety Organization, and the Office of Nevel Research.

One may conclude from the meeting that the idea that it may be possible to determine any subsurface vertables of the ocean by remote sensing is attractive in principle, but realizable now, in a severely limited manner, and atili poseible of advancement. Sound waves are now used for tracking SOFAR floate to mep out deep and mid-level currents. and acoustic lomography offers posalbilities that are now being exptored in the field, with the first tentative results now being reported. Acouatic tomography measures a combination of velocity and sound speed fields over that water column, and the data can be interpreted to give meen variebles and a number of integral measures of wafer properties as well as atatletical measures of the field of variebles. The upper mixed layer is not so well sampled by acoustic tomography, so for the upper layer, ona will have to rety upon other methods. In seltwafer, elecfromagnetic weves cannot be used profitably; for brackleh or freeh wafer overlying sall water, rader monopulee methoda offer some promiee. Such methode ere in roufine uee for ice proing on lakes and rivers, and extension to setuaries may prove uesful and practical.

Satellite Interrogation of drilters, and shore etation trecking of drilting buoye ere other methods of obteining informeflon about the ocean without having to go there each ilme one wante information.

Among the eclive methods of sensing variables in the upper ocean are ground wave and lonoapheric scatter rader. The ground wave radar method, one example of which is CODAR, when used from ehore, can eense tha current flald in the upper 1/2 meter of the ocean with a special recolution of 1.5 km² and 0.10 m/a. While a few examples were given of synfhetic aperturs radar (SAR) signatures in SEASAT-SAR data, the processing algorithm was not described in sufficient detail to enable one to make any judgement about the method, although in principle it ehould be possible to infer current elong one direction from Doppler-shifted reliections. The SAR date also show a strong correlation between ballymetry and eas surface roughness. As el previous workshops where these data have been preel previoue workerous writere unes data nave been pre-sented, there was little, if eny, enalysie given of the dynam-ics of the processes. The active optical methode, using laser light sources, take edvantage of the following effects: tha Raylsigh scattering broadens the specified width, and the broadening is iemperature dependent. Thue, one may be able to measure lemperature by observing the reflected light from pulsed, range-gated lasers,

Next comes Remen beckscatter for measurements of \$2 linity, temperature, end other veriables, and then comes Brillouin ecettering to sense sound velocity. When a very intense laser signal hits the weter, it will also hast it and generate an acoustic signal. The reliection of the acoustic signal back to the surface (by deneity structures) will in the generate a meeeurable eurieca signature. One can use its for depth sounding from airplenes and, ulilmelely, from even more remote pletforms. The combination of possibe. iles, elthough few of them ere now et a siege reedy lor routine precilcel use, suggests that one should follow develop ments closely. The methods, so fer, seem to be meinly ueeful in the upper 50 m of the oceen but may some day be extended to several times that depth. This will tell us very little about the deeper water column. But the possibility of obfaining eynoptic dela, even in the upper few melers, seems interesting. The technology needs to be worked out and the oceanographic community need not yet hold its collective breeth end sit eround end welt, but the new methods mey be upon us in a few years. The eclive and peasive remote eensing of water properties has, of course, also been extended to sensing of biological properties. Here the workshop contelned a very interesting set of papere on algorithms and the inverse problem end an exemple of application of color measurement to mud flat and life

The first peper was by N. K. Højerslev, who showed that different regions of the ocean heve sufficiently different plenkton related color thet a universel algorithm for interpreting color in terms of biological messures will have setous ehortcominge. The next peper, by J. Fischer and H. Grasel, who had examined the problem of remote sensing of particulates, found that the problem of determining parficulete matter variables from color observations was not well conditioned end that the metrix really had only two inearly independent cherecteristic vectors. The tentetive conclusion of this lietener to these two papers was that below one can use color to detarmine biological variebles, one needs to introduce some information about local biological properties as a constraint on the inversion process. This meena that one needs biologists to help with the interpretation; one cannot find a wey where the technology system and the computer can do it all by themselves. This should not be a source of wonder because biology is a nonlitival brench of aclence and cennot be leff to automation. One hae to develop e certein judgement and expertise belore one can produce useful results.

The Coeatel Zone Color Scanner provides useful information for biologista, but the information from the inlensity of color bends cannot be used blindly, it has to be interpret ed through the use of knowledge about local biology es a constraint on the inversion process. An example of how to Incorporate local knowledge in an Inversion problem was given by Prober, Bahr, and Dennert-Muller, who interpreted the LANDSAT Images from different chennels, in terms of tidal flat classes, including dry sand, wet mud, and others by using 'training fields' and in allu establishment of lield characteristics. The use of these training fields introduced the local constreint on the inversion process and made ! possible to cleasify a lerge region from LANDSAT dele aller field work in a limited eree that covered the important clesses of flete.

Thie is apparently the direction in which one has to seek methods for interpreting upper ocean color. Also, no doubt. the same method can be used with active sensors, where one senses the color quality of reflection of laser fights from diferent deptha, including fluorescence effects.

While some of the methods seemed kind of far from practical realization in the near future, there is repid technology development under wey.

The workshop was informative for the perildpanis, and the sober assesaments provided by the working groups showed that one cannot dismiss remote sensing techniques out of hend, thet the technologiets need to should ter acientists to learn whet one should look for, end it showed how one mey edjoin specialist knowledge to 18mote sensing data. In that sense the workshop was educational, reelietic, and productive of eober evaluations of mathods. An abatract volume will be available shortly from the Royal Norwegian Council for Scientific and Industrial Research, Space Activity Division, P.O. Box 309, Blinden. Gaustedallen 30 D, Oalo, 3, Norway.

This meeting raport was prepared and submitted by Erik Mollo-Christensan of the Depertment of Meteorology and Physical Oceanography at MIT, Cambridge. &

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Jepan. Sponeor, Teukube University. (Takeshi ichiye, Oept. of Oceanography, Taxse A&M University, College Sistion, TX

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May 7-20 Genornt Mouting of IAG, Tokyo. Japan, (I. Nokegawa, Goophysical Insti-tule, Kyoto University, Sekyo-ku, Kyoto 608 Japen.)

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May 24-June 4 International Solar-Terrestrial Physics Symposium, Otlawa, Ontario Cenade. (Prolessor Llu. University of Illinois, Urbana, IL 81601.)

May 24-June 4 24th Plenery Meeting of COSPAR Ottewa, Onterio, Censda, (Dean Kestel, Space Sciences Board, National Academy of Sciences, 2101 Constitution Ave., N.W., Washington DC 20416.)

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Aug. 2-13 Joint Oceanogrephic Assembly, Halifax, Nova Scotle, Canada, Sponsor, · Scientific Committee on Oceanic Reeearch. (Leo O'Quinn, National Steering Committee for JOA, c/o Canadian Committee on Oceanography, 240 Sparks St., Ot-lews, Onland K1A 0E6 Canade.)

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Aug. 22-26 11th International Congress on Ilmentology, Hemilton, Ontario, Cenada. Sponsor, IAS. (IAS Congress 1682, Deportment of Geology, McMastar Univer-sity, Hamilton, Onterio LBS 4M1, Canada.) Aug. 22-26 Third Circum-Pacific Energy

end Mineral Resources Conlerence, Honotulu, Hawaii. Sponaor, IUGS. (AAPG Convention Dopartment, P.O. Box 679, Tutee, OK 74101.)

Aug. 23-27 Ninth Annual Meeting of the Europeen Geophysical Society, Leeds, United Kingdom. (J. C. Briden, Department of Eerth Sciences, University of Leeds, Loeds LS2 8JT, England.)

Aug. 23-27 Second Symposium on Applied Gleclology, Honover, N.H. Sponsor, International Gisdology Society. (Secretary General, International Glaciological Society. Lensfield Road, Cembridge CB2 1ER, United Kingdom.)

Sept. Third International Kimberlite Conjerence, Clermont-Ferrand, France, (Francolse Boudier, Université de Nentss, Laboretoire da Tectonophysique, 2 Rue de la Housaintere, 44072 Nantea, France.) May or Sept. Scientific Meating of tAPSO, Heillex, Canade. (E. C. LaFond, LaFond Oceanic Consultants, P.O. Box 7325, Sen

Diogo, CA 92017.) Dec. 6-10 AGU Fall Moeting, San Francisco, Celii. (Meetings, AGU, 2000 Florida Ave., N.W., Weehington, DC 20008.)

July 18-23 Fourth International Conference on Permefrost, Fairbanks, Alaske, Sponsors, Nettonal Academy of Sciences, Stele ol Alaska. (L. De Goes, Poler Research Board, National Academy of Sciences. 2101 Constitution Ave., N.W., Weshington, DC 20418.)

Aug. 15-26 18th General Assembly of IUGG, Hemburg, Federal Republic of Germany. (P. Melchlor, Observeloire Royal de Belgique, Avenue Circulaire 3, B-1180 Bruxelles, Belgium.)

Aug. 27 Symposium Commemoreting the 100th Anniversary of the Mount Krakaleu Eruption, Jakarte, Indonesia. Sponsor, In-donesian institute of Sciances. (Didin Sasfrapredia, Deputy Chairman for Netural Sciences, L1P1 JL, Teuku Chik Ditiro 43, Jskarte, Indonesie.)

Sept. 12-14 National Weter Well Association 35th Annuel Convention and Exposition, St. Louis, Mo. (NWWA, 500 West Wilson Bridge Rd., Worthington, OH 43085.) Dec. 5-9 AGU Fall Meating, San Francisco, Calif. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

FUTURE AGU MEETINGS

December 7-11, 1961, San Frencisco Decembor 8-10, 1982, Sen Francisco December 5-9, 1683, San Francisco

Spring Meetings May 31-June 4, 1662, Philadelphie

AAPG American Association of Patroleum Geologista AMS American Meteorological Society ASCE Amorican Society of Chamical Engi-

GSA Geological Society of America IAG International Association of Geodesy IAGA Intomational Association of Geomagnetism end Aeronomy

IAHS Intometional Association for Hydrological Sciences IAMAP International Association of Meteorology and Atmospheric Physics IAPSO internetional Association of Physical

Sciences of the Ocean IASPEI Internetional Association of Seismology and Physics of the Earth's Interior IAVCEI International Association of Voicanology and Chemistry of the Earth's Interi-

IUGS International Union of Geological Sci-

IWRA International Weter Resources Associ-MSA Mineralogical Society of America SEG Society of Exploration Geophysicists
SEPM Society of Economic Paleontologists
and Mineralogists
URSI International Union of Radio Science

GAP

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Hydrology

Jild Promion and Sedimentation UNSTRADY OUR-DIMENSIONAL SETTLING OF EUSPENDED

S. Chanothetan, J. S. Guillims, H. G. Otefan (81. Anthony falls Hydraulic Leberatory, University of Hinnesota, Kinnespolia, Himmsota

university of Hinnesota, Rinnespolia, Hinnesota 554(4)
A con-dirensional, unsteedy numerical code; for the mriical distribution of suspended solitonal concentration and tate of tumponded andirent deposition in shallow water stitled uniformly has been developed. The advantage of distanton equation is suited by a fully implicit, especialist finite officience tchase. The computations are unconditionally atable respection in the computations are unconditionally atable respection in the testing and except modern the particular for the control of the control of

1110 Irosion and Sedimentation
CANGUEL (NSLABILITY IN A BANDED, SAND-BED RIVER
V.L. Gref Jopartment of Geography, Arisona Stace
University, Iempe, Arizons, 85281)

The Gile River of canirel Arizona is representative of braided, hand-bed rivers in ellevini
validays that have inhorest unstable behavior and
dattractive channel signation. The 112-year
record of chemnel conditions along a portion of
the Gile River provides date for the Communication
of localismal probability caps for sain-flow
channels. Jones of stebility and hasardoes inciability elternate with each other at 1.2 km
12 mi) intervals. During the past centery, the
aversil sinusity of the main flow channels has
remained close in 12 despite numerous changes in
subreaches are reselt of cedimentation bailind a
dar and fluctualisms in the dentity of phreatophyte growth, which both affect the hydreelice
of flood flows. Unstable somes of the channel
correspond to the turface of the sediment wedge
prients. Siable romes correspond to areas controlled by beforch or man-made cfructurer, at
well at locations determined by these searmel
factors plus the requirement to mainfain a conrictions sinussity. Channels such are the tof the
Gile River de not reset most estamptions of equiibictum, and as a best enderction disnosph probabilitatic approaches with an examption of
cliationships, died channels).
Value Reasour, hear, Japor 190384

ALES CIRCLOLOGY
A DETAILED STUDY OF SNOW ACCUMULATION
AND STABLE ESCROPE CONTENT IN THE DOME C (ANTARCTICA!

J. R. Petit [Laboratoi re de Giaciologie, CNRS f. nu Très-Cloftrae, 3803] Grecoble Cedex France) J. Jouani, M. Pourchet and L. Merilvat Snow samples have been jaken je the once a simples have been taken in the Come C erce with the purpose to study the varietions of the exemulation rate and of the exhibitions content over the last century. Stakes observations indicate a large spalled variebility of the accumulation rate. the accumulation rate of a oes year touis (or * 1.6 g/cm² /yr for a mean value s = 3.6 g/cm²/yr)
The depth of the 1965 and 1955 layers determined

The depth of the 1955 and 1955 layers determined from beta radioactivity measurements in 19 elies altows to dedect that the spellet variability becomes a mail et elan year scele to = 0. 3/cm par year) abowing that the anow sollouted at one point is well representative of the fallen presipietto over this period. The rete of seew secumelation over this period. The rete of seew secumelation elane 1955 is about 10% higher than derive the 1955-1965 period. This can be respected by measurements over a large most repperted by measurements over a large most repperted by measurements over a large most repperted by measurements over a large most selected by the second of the seew accamaled in high second of the seew accamaled in high second of the second contained profiles; by comparing with the beta and tritique radioartivity determinations if it is shown that the destrium variations of its series and in such a second tradition of the second respective of the second radioartivity of the second radioartic of streig raphic observations of second radioartic of streig raphic observations of second radioartic of streig raphic observations of streig raphic observat

minte, Ogogrephical changen of the mase deute-flum content are relatively mainly cheeping that

at a ten scale the isotopic signal to well repts sonistive of the mean deuterium content of the precipitation. This tractes that the amounted (ten years running mean values) deuterium. profite obtained over the last LbO vetra prosuier Irend in the Dome C area (Snow accumb lation, sieble teolopet in enow, snow stratt grephy, redicactive fellout) I. Comphys. Ess., Grean, Japer ICE715

3130 Groun-Mater
TRANSPORT OF LON-EXCHANGING SOLUTES IN CROUNDWHIET CHBOHATUGRAPHIC THEORY AND FLELD SIMPLE

White Checkton Aprile Theory and field Signation to the Country of the Signation of Civil Engineering, Stanford, Caiffordin 94203) and J. Roberts
Equations describing the transport of lon-axchenging solutes goversed by local chemical squilibrium through a satutated percent adjusted through a satutated percent of the control of the general multi-species equations typically senting squared multi-species equations typically senting squared multi-species equations typically senting squared multiple fromts and places a room. This paper presents an energited framework, based upon the chemicalization of certain key communities a priori chemicalization of certain key communities of the profile lectures. The coses studied include both chemicalization of certain key communication profile leavures. The coses studied include both homovalent and hoterovalent oschange in bluery and ternaty systems. In order to tast its validity, the chromatographic analyzis is applied to a field project involving direct injection of sevenced-treated municipal off-luent into an applier, his of the sojer jostures observed to the evolution of the ev able field date are accurately predicted by the shango, thromatography, porous medium) Water Resour, Ses., Paper 190717

3130 Groundwater > COMPARISON OF THE INCOMPLETE CROIBSKY-COMINGATE GRADIENT METHOD WITH THE STRONGLY IMPLICIT METHOD AS APPLIED TO THE SOLUTION OF THO-DIENSIGNAL GROUPD-MATER FLOW EQUATIONS
L. K. Kufper (U.S. Gooingicel Survey,
Surce, South Dakote 577571)
This paper commarcs the efficiency of
the strongly implicit procedure (SIP)
ond the seconplete Cholenky-coepugate
gradient method (ICCG) sopiled to the
equition of the finite-difference approximating equations for groundwater flow.
Results for five legitopic two-dimensionall tost problems are crosseted. Three Il took problems are organized. Three at their problems are organized. Three are linear confined-aguifor occidents, and two are nonlinear weter-tebla aguifer problems; in oll but one of the teal problems the equifer was considerat to be northemogeneous. Each SIP and ICCG me applied to weter-table odurier problems Make use of iteration assumetors. There were varied for each of the test problems were varies for each of the test propers to reduce the secure of computational work seed to find a solution. ICCG assumed the secure of reducing the secure of the continuous sip when applied to the continuous surface surface to the continuous surface s later Ensour. hen., Paper 190716

Il 10 Groundwater
EffERT OF 6171 UN PLAIL INVESTMENT IN POCE ERACTURES
Faul A. Withorm oon (Laurence Berbeler Laboratory
und Separtusest ui Maroriais Science and Mineral
Englometas, University of Enflormin, Barbolum
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Laborstory studies on finish flow to single fractures in sock conflow up to a noter le size suagest that I hote is a delicite ptobice of stells. Two sech studies have hear aspetted, but the transite are not commission. The sensingity conicodiciary results may likely be a smallering to conformation. The sensingity controdiciary results may likely be a smallering to make the first of the offices of fracture surface roughness. A basic problem in attempting to enderstand the plysica of first of tractures is that of understanding the affects of surface roughness. The investigations that ste envisioned to attach this problem util only be possible on rock samples that are nuch larger than the conventional size.

STEADY PERIODIC FLOW THROUGH A RECTARGULAR DAW

J.S. Enight (Olvision of Mathasaries and
Siccistics, CBIRO, F.O. Box 718, Lindfield, NOW
2070, Australie)

For wasteady from ourface flow through a recrongular pursue dam, a simple relative which
connects a pressure integral with the movement
of the free curtame is derived. For steady
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teads to on average discherge formula which is a
geografication of the Dugust-Forchhalmer
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Forebheiser theory, tidei effacts). Water Resour, Res., Faper 190499

3130 Groundhefer
AMALYSIS OF FEGN THROUGH SETEROGENEOUS RAMBON
AGUIFERS BY THE METHOD OF EMBEDDING MATRIX.
PART (: STEAD) FLOW
G. Dagan (Schoold of Inginsoring.Tel-Aviv University

G. Degam(Schoold of Ingineoring Tel-Aviv University Tel-Aviv, Israel)
Tel-Aviv, Israel)
The statistical himstures of the hydraulic conductivity, head gradient, specific dihebarge and head fields are unelyzed with the sid of e simplified ends) concluting of a collection of hyberical (in thread dimensions) and cylindrical (in two dimensions) blocks of different conductivity and dimensions blocks of different conductivity and unbounded formations effective conductivity and unbounded formations (Degan, 1979) are recovered and given a their darivetion. The influence of the quiffer boundary and noruniform everage flows are exemined for the first time. The growth of the head variance with diebence from boundary in two-dimensional flows is compared with that of Monte-Carlo 31-mulations of Smith end Freeze (1979). Mater Resour, Res., Paper 8091010

THE STATISTICAL MECHANICAL THEORY
OF CROCKEMATER PLON
G. Sponito (Dept. of Soil and Empireo, Salancem
Onlywestry of Californin, Riverside 91981)
3.-Y. Cho
The macroscopic differential equations of
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3160 Hydrology: Run-aff and streemflow EFERNINATION OF THE CONFIDENCE INTERNALS OF THE STATEMINATION USING CROEK STATESLICS. Bobbe Université du Quèbec, INRS-Ree, C.P. 1900, Sta-Foy, Quèbec, Canada) P. Bounhor Facent results, thou has internal of the Vakely distribution to represent frace flows. It is postible to determine in an espiciet fashion the distribution of the order statinties for the vitely distribution. The determination of the centifence inferents for e given lavel of an inset of return procedure is well of or lively distribution is fitted to a sample of vice that general procedure is well of or ell estimation and of the permaneter of the Wakely distribution and gives a good approcimation.

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ESTRACTION OF ESTREETS LOW FLOWS FOR FRANCE
SOURCE EMPRIORS DESIGNS
A. V. Kessalis (Department of Engineering
Karbentice, The University, Neucastis upon Tyes, Ratheratics, The University, Rescastis upon Ty Exited sed J. A. Massalay
A sathch for attinuting the probability of con-secretance of law flows for a reservoir fablectly by one river with additional pumped islow isses account river is described. The mained is based on the joint probability distribution of an extreme value distribution of a regress will be distribution. The regress of the probabilities of given low lines are given by location. flow are given by integrals. These are critically for a range of low flows and extract drift pumping rates, betails are given for the particular cate of total inflow heing a three consecutive month period, but

COUNTAL FLOOD PREGUENCY CRITICATION AND NETWORK DESIGN Full P. Greis and Scie P. Wood (Department of Civil Engineering, Princeton Boiversity, Princeton, NJ

The sain of probability weighted moments has been insettigated for improving tetinates of itself recovered quantils syents to both gauged and ungauged tetins. Fagional actients at gauged nitte are infrowed even more consistent and introduced the state of the probability weighted moment took introduced both and the probability weighted moment took in the state of the section of t

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FER MODELS FOR FLOOD LEYER DESIGN
I. A. Tura 10-ps. of Chvi Eng., University of Nevtia, Ren, Neradal and L. W. Mays (Department of
Lord Eng., University of Texat, Analin, Texas).
In the design of Rond fewar systems there are many
planters and variebles with associated uncerfacilis. Int paper present models which systemstedly analyze the various types of unceresteries in
fis hydrogic aspect as well as hydraulic aspect of
design and analyze to delian the stak and reliability of
descrapsing. Both scalle and line dependent risk
redds are developed. Results show that risks evelused by the ample return puriod method can be
restrained by 10% 10 30%, depending on the
Coding distriction model used. The risk-astery lacto relationships are shown to be very security to the
rectalized issuing probability model adopted, so that
Composite models are singlected for rick easilysis.

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L Jevis (Sepatheman of Geography, State University of New York 1250) and D. Shem
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3175 Boll moiscum CASOPY TEMPERATURE AS A CROP WATER STRESS CALOFY TEMPERATURE AS A CROP MATER STRESS
(NUICANO)
5. O. Jachego (U. S. Varer Conservation
Laboratory, 42) S. Broadway Rd., Moomix,
Arizono 350401, S. S. Ideo, S. J. Regirnto, and
P. J. Finter, Jr.

Arican 350401, B. B. Ideo, S. J. Ragimto, and P. J. Jinter, Jr.

Canopy temperatures, obtained by infrared thetwosetty, atong with mi- and dry-bulb sir temperatures and an estimate of any raflecten were med to equations derived from energy balance rosaideracions to catcuists a trop rater atreas index (CMEI). Theoretical limits were developed for the anopy-air temperature differences as related to the air vapor pressure desicit. The GME in shown to be significant in ST2, the mule of actual to potential supportraspiration obtained true the Pranan-Montaith equation. Four esperimental plots, planted to whatt, teceived post-meargence irrigations at different times to crust different degrees of water ethmse. Partieset variables may emasured hactween 1300 and 400 and day (except nose weekends). The CWH, plotted as a function of time, closely parallaised a glot of the estrathable soil water to the O- to 1-i-m sorm. Usefulness and finitations of the lower emapy temperature, infrared thermostiy). Water Resour. Bes., Paper 180449

3175 Soti Molecure STATISTICAL ANALYSIS OF THE SROOKS-COREY AND THE R. S. McCuen, W. J. Arvin (1506-5EA, Building 007, RASC-West, Ogicavilla, Karyland 70705t and D. L. Srakonsiak

infiltration is a sajor companent of the hydro-logic sycia for meat metrebade. Therefore, it to important to ham a method that can provide meersheds. Both the analysis of veriance an indicateh that the parameters for the two module asselded veried collectively across soil testure tlates. Mean personeter velues and standard errors for soil testures are prosented for

3175 Bott cofeture TWD-UIMENHORAL SOTL HOISTURE FLOW IS A SLOPING RECTANGULAS REGION; EXPERIMENTAL AND MONTHICAL

13. L. Pisher (Capartment of hgricultural Engi-neering, Taxas has University, College Station, Taxas 77543; and 8, 7. Malter Results from eapsticants with a 7.55 meter by 0.58 meter by 0.108 morer flung filled with sand are used to study the two-distinational flow of soil mojeture moder the condition of raintell insolt molature uncer the condition of paintail of filtration, The empericantal results are compared to results obtained by a numerical solution (via a inite miement-finite difference transformation) of the total department of the total department of the form of lieu tied and the condition of the total department of the form of lieu tied and the condition of the total total of the condition of th readitions fhydraulic head distribution and posi-conditions fhydraulic head distribution and posi-cion of the phreatic surfacet and the rising limb of the tunof | hydrograph. The appringnum and the numerical results are in sarisfactory agree-ment when the offact of empitiary hysrotechs is Incorporated into the numerical solution. Manacayillary hysografia is ignored the numerically simulated hydrograph lags for behind the apparamentally derived hydrograph. (Sell relating

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APPORTIGINENT OF SET RECHANGE IN LAMBILL COVERISE LAYED INTO SEFARALL COMMENTS OF TERLICAL LEAFAGE LAYFO INTO SEFARALI CONTUNENTS OF VERILLA LEAFAGE AND MOSICONTAL SLEFAGE
John J. Lanta (Johns Heghins University Applied
Physics laboratory, Lautil, Maryland 20310, USA1
Satplus soil moleture is a sloping leadful covmaking layer is apportioned into a vertical leafage
frarrion sed horicrotal sempons featilan by atmaning vertical liew toust into hydreulic tendutylvily of the wests and Darriag horisontal flow
choughs veryley vertical tron-section at a velocity detarmined by the hydraulic conductivity of
the towar layer and in predicts equal to the alope
of the interface between the towar layer and the
wests. The governing equation is set up by imputoutput manysis, and differentiates into the
Bosteissed equation. The resulting pertial diffeateurial equation he selved by immression. A
selved numerical exempts is alreo.

METAL ION DEMCEMBRATIONS ## SOCIATED WITH LATE SURVER SEDIMENTS OF THE ORIO SIVE.

5.7. Spuncar (Department of Chemical and Environmental Engineering, Speed Ectantific School, University of Louiswills, Louiswills, Kanjucky, USA)

C.A. Lauchart, and R.S. Colyer
The fine lete number sediments of the HcAlpias pool of the Obio liver are described as composed of severage XI by dry usight volatile solids naturals. The volatile solids composed was found to he sapeciated with virtually all of the DOO, hydrogen, sodium, potasmine, sunsimum, nanganess, and land, se well as a significant portion of the scaboo, chreatum, iron, copper, and zino. Kannasium was found to have all of its said soluble composar associated with the sunvisities portion of the sediment. The schiant therium and ormelum consentration of nound to her justified in the scale soluble composar secritors of nound to have in the schiant therium and ormelum consentration of nound to her justified in the sunvention of the sediment. The schiant therium sed ormelum consentration of nound to he in justified in the sunvention of the sense of the potential aifert of this late summer artiment on squatis diffuse sungarend. (Metal Ioan, rimr sediment, Ohio Simr).

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Eguations for enlouisting bydravite
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gradient did not course infone errors to the
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(Hydmulic conductivity, usesturated soils,
infillention, derinage, osisole, soil water
authous. Marer Resour, Res., Paper 190656

.3190 Hydrology - Instrumense end techni-A SUPPLY OF NATHEMATICAL OPTIMIZATION HOPELS AND ALGORITHMS FOR DESIGNING AND CATENDRY ISRIGATION AND CATENDRY NET-

MODELS AND INFRIGATINE AND MASTRATER AND EXTENDING ISREGATINE AND MASTRATER AND MORES. Christoph E. Handl (Inetituie for Advanced Studies; Studergases 86; A-1050 Vichnia, Austria)

This parer presents a state-of-the-art ourway of setwork models and algorithms outway of setwork models and algorithms in thet can be used as a nlenning bool in irrigation and wastrater gyotams. It is irrigation and wastrater gyotams. It is seconding such a yetams, bagically leeds to exconding such ayetams, bagically leeds to exconding such a yetams, bagically leeds to exconding such a system the difficulty in splying ting nodel. The difficulty in the properties this model lies mainly in the properties of the objective function. Trying to minimize construction end/or operating costs mize construction end/or operating costs prize construction end/or operating costs mize construction end/or operating details in a convey cost (objective) function, due to

economies of scale. A number of vavo to attack such models are discussed end concerds, lesiuding linear erogramming, infeser programmers and smedielly designed avact and heuristis algorithms. The usefulness of sech enumbers of the roled, the concerties of the validity of the roled, the concerties of the algorithm, the promerties of the absorption, the promerties of the absorption availability of software and the condition are statistically of software and the condition of the appropriate of the software and the condition armany, integrate, usagement.

THE IRRIGATION EXECUTION TROPERS AND EXAPOTRANS/IRATION LIMITATION TO THE PROPERTY OF THE PROP ast beneates from a crop facing uncartain, cormised, owepstampjration denands. Weehly ittigation decisions are made after observing current soil poleture and evaliable irrigeston water, as well at poleture and evaluable irrigeston the past week. The model is similar to the traciditions reservoir control algorithms (opular in the surface water literature. A case study example indicates that although the model fortulation is madel and impaths, the offect of uncertainty owentiagenessis on training of the company o

uncertain ovapottanaptration on irrigation paractrance reasures is apparently minimal (irrigation, mulpottanapiration, dynamic programmingi. Water Sescur, Kas., Papac IVE731

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Meteorology

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1 slow in garpter spectors of 11 but attache comindence: The first at the set of stations with shorter data receive them to settle in the send of finitely. The average change is the sun of all ling term global trends. The routisens are alterated that the variation arong stations and include all effects that differ from suntine to station. A crown prehamene availation of north traquety and real state settrations in the tratistical methodology have and small effects on the results. Addition of longer trains in the statistical methodology have and longer than the observed average change decreases. With each year't may dear it to exceed that the dependent of the station half that hypothesized by current stronger than the observed average change decreases. With a depletion half that hypothesized by current stronger to all a due to chiotofluorecorbons (CCC'al woulf be delected). These stations provide a good sarly wanting of any depletion that eight be due to IFC's.

J. Gasphys. Fas., Green, Paper 100787

1715 ibenical composition and chamics? PILS Shemical Compension
isteractions
ATMOSPHERIC CARBON GLOUIDE AND CELOMOTHDOROMETHRESS: COMBINED EFFECTS ON STRANDSPRIZE (C
02001, TEMPLIATURE, AND SUPERIC TEMPERATURE
L. S. Catile (NASA Lengley Restrict Center,
Hempian, Virginis 1865) Hural Reterjam
Time-dependent returns memarine for terbon
dioxide and chloreflonromathabon (CECL); CTU

chemical model. A steedy-state version of the model is used to determine earlsce compercure affects and to establish asymptotic issues. Sesuits indicate the following: (1) The total ozane time history is atgaiffeently different from the destate the oblight interests and ozone time history is significantly different from that due to the chlorofluoromotheous alloes (2) h inval otone minimum occurs in the upper attratosphere about \$5 years from the present with a tubequent some increase, than decline; and (3) Strady-state solution indicate that tropospheric temperature and water wapour increases, associated with increased infrartd opacity, cause significant changes in tropo-sphoric orone levels for \$ 0.0 and \$ 10, with and without the addition of chlorofluoro-methance. (froposphoric stods, granduce effect, Cogl. Coophys. Zes. Lutt., Faper (10804)

3715 Themical composition and chemical Internetions THE DISTRIBUTION OF CAPBOS MONOXIDS AND OZONE IN

THE DISTRIBUTION OF CAPAGE MOMENTES AND OZONE IN THE FREE TAGIOTHERS.

Y. Heller (Max Flenck institute for Chaslessy, Searstrass 13, Disco Mains, Sederal Papublic of Oarmany) J. Flence
The two-dimensional distributions of CO and Oq in the free troposphese during July and August 1974 are directed. The data confirm the previous flodings that both of shose games are considerably more abundant is the Northern Benispheta, but the degree of the asymmetry to asmewhat different from what had been reported yreflowed, sepacially for CO. When extend vich respect to other available data sate. The conclusion is drawn shat a producent desironi sytic salata for CO in both hemispheres which may be driven by the lifely seasonal cycle of the Oil radical. The data size indicata that CO concentrations sability significant verisability with beight in the Barabern Benisphere whereas trations exhibit significant versative whereas beight in the Surabern Semighers whereas scuthers had spheric continuations are quite sanutate with skilling except in cases where interheatspheric actions of air may be occurring. A discussion on the vertical and before a transact processed interior live occurring. A discussion on the westlend and bottomath transport processes injured larm the 10 and 01 measurements in presented. The observations indicase that the gastern between 10 H and 40 S is very active procedured between 10 H and 40 S is very active procedured by it is at these lacitudes where the til concentrations may be the highest during this time of the year, resulting in an area where the fit destruction rate and the fatto of in-site transported at the fatto of in-site transported action may be the greatest. (fatton monophys. Res., drawing paper 10 1786)

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Concertantion J. M. Moson suggestions of Physica and Sattomony, J. W. Moson Superfront of Physics and Satronay, Unionizity of Mediting, Israels, Med. 2021; and Saller i horse commonwest of the small for communitation were note union a torotten or adenual, by sayingment differs from others to that a luberous were noted to draw att through the irr collector than theorems a well be, and and constant flow rate, the irrelates were found to be quite required to the professional of the posterior to the profession of the received are medited to the profession data, the respective are medited to the profession data, the needled in the third distribution in the state of the profession of the distribution of the state of the collection o

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3770 Particles and Aerosols
APPS/OL FORMATION, IPANSFORMATION AND SITECES IN
UNIVER'S INISSICAS FLUNG.
C. G. Fan Valle (Office of Neather Pessarch and
Modification, EPI, MOAA, Sounder, CO 80303)
R. F. Neutchal and D. L. Wellen
Aerosols and frace gives over the Denver Extropolitan area and in one tate to 175 in dominind
were ressured with an instrumented alreads.
Typical hearground concentrations seasured above
the politade layer were: If this sattlering coafficient (bacac), 9.2 x 10°50°, Inial particle
ties concentration, 1 - 5 a 10°50°, 0, 30°
parts par billian (ppb), 50, -5 ppb; MO. 4 a
ppb; MO., 5 ppb. Below the inversion and mear
the city cesiar (main arissions source) typical
measured values were as follows: bcat, 0.5 1.5 r 10° vs²; (M. 10° cs²²); 0, 10° ppb. As
the plum aged, the CN concentration was found to
decreate to one-shald or one-fourth of the initial value, but bacat intreplach in one intelence
to 4 x 18-3 m² with increases in particle
population in the accuralation mode. At the
same line the MO, toneaniration was only about
1/10 of the value predicted by the 0, and NO
concentrations and total irradiance; removal of
MO, by distolution in Hauld water is indiceted.
for rafractive traities at sumed to be resultatic
for dry urban carrieds, the absorption-to-backscallor ratio decreased with inaccasies age of
the claud. Therefore, fearby toward ned sasten
olives had the potential to warm the oincephore
were smilest, via tailer 10 h the pluma had rach
last acroing potential; toolling probably occurred
over rost surfaces.
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7, Acethys.

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The Warfact Terriory
Raigh Fath 10-ye, of Astronomy, Cornelt Universi-ty, School, NY 1881) Sichard Goody and James

Cy. Makes, Hr 1981; Sichard Goody and Fames Polisci.

The charying sky triphoness dusting the macross swill jak to treatured by the Viking Lander carones has been conjugated with calculations raced upon scalars of the surrosses in the martin atmosphere. Our satisfies not discriminate strongly between coulds but an exponential distribution of dust with a sequential distribution of the stephenic scale height is consistent with the stage of the light curve, and there is no tribution of dust layers in the square at respect, a could, such a layer in the square an injuried of constitution to the intensity of dust tuttiper, in addition to the intensity of dust tuttiper, the addition to the red dust, winds frighted statement of caroner may be required to tage, thus too such a formal daying the statement of the calculation of the statement of the statem

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3790 Instrucents and Lechniques Imeteorology)
OR THE SERSITIVENTY OF NUMERICAL MEANING PREDICTION
TO REMOITLY SERSITO MARINE SUMPLEX HIS OF REMOITLY SERSITO MARINE SUMPLEX HE ASSESSED IN A CARDON NATION STORY
M. Cane (54-1720). Assessment it institute of fachnology. Carbridge, MA 02139], Y.J. Cardona,
M. Haler and I. Malteretars
A series of observing system standard experiments has been performed to assess the potential impact of marine furface wind differ an unwertest woodhar prediction. Caca assistent adultate and the applicate that spatial sowers and early checked the property. Caca assistent adultate after conventional surface, radiosomie, ship and sirversal in a surface, radiosomie, ship and sirversal reports. Those observations, suitably degraded to account for instrument and sampling arrors, were used in a someonismal snaigals. Overcost cycle. A series of fire P2-h forecast earn than rude using the ansignad fields as initial sanditions. The forecast acrong growth as found to be similar to the in peculional manerical forecosts.

Further opportments simulated the impeculing

tial sanditions. The forecast acrongrowth as found to be station to that In speculional magnitude forecasts.

Further opportunits simulated that lea-continuous assimitation of remaiely sanaed carino surface used or temperature stunding data in addition to the costant loss data. The aind data were fabricated directly for model grid paints intercepted by a Seatet-1 scallanomater [5855] tests and some piscod in the lowest active level [945 mb) of the model. The temperature sounding reportunent assimilated error-free data fabricated sing actual hirous orbits. Forecasts were node from the resulting analysis fields and the import of the simulated rate little data and stressed by concerning faces forecast errors with those of the control forecasts.

When error-free winds were destricted using a localing face forecast correction rethod (SCI) the impacts in estratropical regions proved to be solved in a surface pressive. In contrast, a less sophisticaled assimilation method retained in sufficient with the serior face sounder data (again by the SCI) give impact contrating the impact alone may be a visuable as temperature soundings for numerical weather prediction. The official of neutral 285 errors [22 or 1 magnitude, 121 in direction) on the significant serior for product and the serior product which is called the serior prediction in the serior wints, scatter over repose sensing).

1799 Ceneral or Discrimenous ANALISIS OF LIMEAR AND MOMEINEAR INVERSION OF OPIN-TAL DATA 409 8 BICROWEZECHOLOGICAL TEMPERATURE PRO-

Villan H. Mach (Department of Mateorology, Florida State University, Taliohasses, FL 32306). The practical inversion of optical data for a microsterial inversion of optical data for a microsterial inversion of optical data for a microsterial inversion of e system of polynomial squallona. A assince of continess least squares can produce a physically acceptable solution of this notifies inversion problem. Because this author, which is demonstrated with the inversion of singulation, the league of targets are calculated and used to remote the solution. A solution of the

izvestiya Atmospheric and Oceanic Physics Volume 16. Number 4

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Golltsyn G. S. Sission of the Division of Oceanalogy, Aimosphoric Physics and Geography of Acadeau ul Sciences of USSR togsther with the Interdopartment Scientific Council of Academy of Sciencies and State Committee on Hydromeierrology and Cantrol of Environment on the Problem The Weether Forecasts (Novosibirak, 1—2 November, 1979)

Genin V. N., Zuev V. E., Kabanov M. V. V All-Uolon Symposium on Lager Light Propagation to the Atmosphere Ivanovsky A. I., Koshel'kov Yu. P. Studies of Stratespheric and Mesospheric Physics Reported at XXII COSPAR Session (Bangalor, India)

Rozeoberg G. V. Sovist-American Forest Aerosol Expariment in Abasiumani 445 ALOIKUREO

nonlinear inversion problem to physically acceptable when these images agree with simulated images to within expected errors of measurement. The continuer inversion of aptical data contendanted with errors is shown not to be a difficult problem, because the method of nonlinear least sequestingle-cause the method of nonlinear least sequesting in the particular polymonial equations that must be inverted. [Fonlinear least agerts, Miragest.]

J. Reophys. Sec., Green, Paper 100639

1799 General or miscellensous
SOME ASPECTS OF THE COUPLING BETWEEN RADIATION,
CERTISTEN AND DYNAMICS IN THE STRATOSPHERE
Samols 1. Eartmenn (Despatement of Atmosphoric
Belescos, University of Vasbington, Eastle 98195)
A number of machanisms involving locaraction
between reddelion, photochemistry and dynamics
which any effect the thermal compectational or
dynamical structure of the atmosphere are discussed. The effect of coupling between tedistive
tronsfer, photochemistry, and edwardion of oxone
by stratospheric ulude on the effective releanlion rate of Leoparature percendations is littletronsfer, photochamistry, and advection of osome by stratospharic tinds on the effective releasu-tion rate of temperature perturbations is lifeu-trated through the use of four nearpies. It is shown, for the vartical structure typics to planetery waves, osome fluctuations act to heaten the televation of temperature perturbations in the topper stratosphere and to slow the relaxation in the lower half of the stratosphere, where the complime between chesisal sources and in the lower half of the stretosphers.
Mast the coupling between chemical sources and sloke of occue and edrectice of sir by solions is discussed. I simple Lagrangiao model is esployed and related or results from Euleries model sindles. Suphasis is piered upon the iergs addy framsports produced at the transition lowed between dynamical and photochemical control of cause, and also upon the stem counts locrosess which addies on produce is regions where there are shorp gredients is both the equilibrium opens cixing ratio and the relaxation time serie for some parturbations.

Hostif, the spatial reviations of the afterties released to the action rate of temperature perturbations.

Blosify, she special reviations of the affective ralesation race of temperature perturbations are shown to be potentially imported to detarmining the mean structure of the seracesphore doring the wincer assoco. These special variations is the relexation of temperature perturbations in the relexation of temperature perturbations rank time and times. In perticular, a rapid increase in the effective droping rate of planetary waves between the utdies and upper arrateciphere leads to a rapid increase with height of eddy hest transports produced by the coupling belesse redistributed and drumales. This in form can produce a significant modification of the scale seen structure of the upper atrateophere, J. Csophys. Res., Green, Paper 100221

Mineralogy, Petrology, and Crystai Chemistry

4210 Ccyntal chemintry THE CRYSTAL CHEMISTRY OF THE URANYL SiltCATE HIMEALS

F. V. Stohl (Sendta National Labocatorios, Srg. 47fl, Albuquerque, NM 87185)

G. K. Smith

F. V. Stohl (Sandta National Labocatorios, Srg. 47fl, Albuquerque, EM 27155)
O. E. Smith

The urenyl siliceta minarale have been divided into three groups on the bean divided into three groups on the bean divided into three groups on the bean divided into three silicon eatios. The ili group laciudes uranophana, betaucanophana, holtwoodite, sodlum holtwoodite, sodlum holtwoodite, sodlum holtwoodite, sod previously repoeted structura detarmination of uranophana, a structure determination of holtwoodite, sad previously repoeted structura detarminations of most of these minarale indicase that they are rowposed of uranyl ailicate chaina made of edge-sharad uranyl minore chaina have the romposition (100,11516,1)²⁷ and are occasiinked by a bridging only and silicate the transpecture. The uranyl minerale with a uranyl milicate shaet, these sheets era cross-bonded by the seditional cations in the arructure. The uranyl minerale with a uranium to eiliron ectio of irl include weskeite and halweelte. A partisi atructure analysis of weskeite euggeste that the atructure type for this group consists of uranyl silicate chains, sisiirs to those found is the ill group, that are crossinked by the additional silicate tetrahede la the atructure. The uranyl ait has a uranium to siliron retio of 211 mostales only the mineral group aith a uranium to siliron to give a three-dimensional framework structure. A new teiclinic uranyl aitfoate mineral quale silicate that the sudy, although there is not enough sample to describe it adequately. The locations of the uranium etoms in this structure indicate Shut it may not be composed of uranyl efficate chains acone composed of uranyl efficate chains acone et hose found in ait the other uranyl aiticate minarel, uranium etoms in this structure indicate Shut it may not be composed of uranyl efficate chains soch es those found in ait the other uranyl aiticate minarel, uranium etoms in this structure indicate Shut it may not be composed of uranyl efficate chains soch es those found in ait the oth Am. Klanralogiat, 66, 5-6

4210 Crystal chemistry TRE "10A PHASE" IN THE STOTEM MgC-SIO2-H20 J.F. Bauer Johns-Hanville Rememon and Develop-ment Center, P.O. Bon 5108, Denver, Colorado 502171 C.B. Scier SOLIT C.B. Scint

The 10A phase is a nsique pressure-dependent
hydrous phylicalificate in the system MgO-3102-MgO
which is ctable of pressures halvesn 32 and 95 he
and temperatures up to 535°L. Although it are
previously observed ried as e2-outshedral manher or the sice family, remandantion of this
hase has resulted in a new chartest and attrutural madel represented by the formula
[1890_1-14] Mag Visig Wogg (08] 21. The results of
X-ray powder diffraction satisfas, thermal analfals, and experiments in which the stoichlosstry
of oxide starting situres was carefully nontrailed indicate that the attructure of the fol-

troiled indicate that the structure of the foll phase is that of a fully trioutshedral 2ti phylical sittate it is a fully trioutshedral 2ti phylical site and it is a fully trioutshedral 2ti phylical sites additional rhemically-bound "seyer" is 12-toordinated sites [1200][211][27][28][29][202][201][2]. The results of infrared apportunetry, hosewer, indicate that ible "water" is best represented as indicated and indicate that ible "water" is best represented as indicated as indi

18.0° CM - E_0° + 02
or [1H_20] Xilleg V Sill V O_20(00); [+ [1H_20] Xilleg V Silleg V Sill Amerikan Mineralogist, 66, 5-6

4220 Description ainstalogy MYDDONHARMAL ALIGNIUM IN RESEARCH URILL HOLD WY-2, LOWER GRYSE MASH, VELLOWSTORE MAIDMAL ALIGNIUM AND MAINTENANCE MAIDMAL A. E. Barpar And M. M. Bescon (U.S. Gallogical Sarvay), 345 Middlelleld Md.; Henly Pach; California 94025, 7-2, 8 U.S. Geological Sarvay cessorch dismondarill hold in Lower Gayaar Entis, Tellowsisme hatimal Park, hes vir villed to 5 dupl of 157.4 california structure of 100 penetrated interhasional california structure and irreference abolica in glarical delal isologous structure of 100 places in Glarication (51st 100 places) in Glarication 151st.

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layared wifn pumiceous tuif from 10.2 to 31.7 s, and rhyalific layes of the Elephant Back flow of the Contral plateau Meobar and the Hallard teta the Contral plateau to of the nearly continuous drill rore. Shyolitic plate has been extensively algorithm and the Contral teta to clay and recitic minerals (tobarcedida meulandia, clinoptilolife, mordenife, monitorillanite, and illita in addition to quartic and edularia. Numerous veins, vugs, and fractaires in the corocostale hose and other minerals: sitica minerals is total minerals (appl. 8-critfobalita, a-ccisiobalita, and chalicadony), acolitos [analita, civita minerals], corbonals (calcite and ciderilo), clay [kaelindicadony], acolitos [analita, cand production and inclinita). Andlet [hematite, gashitte, manganite, crypiundiano, pyrolusito, and groufite, and sulfides (pyrhotila and pyrito) along aith minerals alice (pyrhotila and pyrito) along aith minerals alice (pyrhotila and pyrito) along aith minerals alice (pyrhotila and pyrito). Interbedded icovertino and cilicaeus sinisr in the upper pars of fine drill cora saicas that two discinct types of hermal water are rasponsible for procipitation of the surficial depotite and furture that the under cogise has alternated hotwom the fine hermal waters mora finan ance sinca fine and sodium- and polaction-rich hydrolbersal minerals alice suppests fact the water shealary in this drill hole verice with depth. [Vallowatene, hydrothermal electrolog, clay, acolites, silica minerals, corbondies, sulfider, edides, edulacie)

Am. Mineralogist, 65, 5-6

4230 Experimental minoralogy and petrology PARTITIONING OF REE BETWIER MINERALS AND CORXIST-ING MELIS BURING PARTIAL MELTING OF A GARMET HERMOLITE Wendy J. Harriton | Sh6-NASA Johnson Spite Center, Houston, TX 77058) Part(fion coefficients $|\underline{\mathbf{D}}_i^{-\mathbf{b}/\mathbf{b}} = \underline{\mathbf{C}}_i^{-\mathbf{b}/\mathbf{c}}\underline{\mathbf{b}}$, where

G is the concentration of element I in photos e Gt is the concentration of element in phetat g and b) for Ca, Sm. and Im bothern gernel, clientrywaters, orthopyroxene, olivino, and belt bare been determined at 36 bbar for 2.3, 8, 20, and 37.75 melting of a garmet thereofite nodule with shoughtlic REE abundances. Partirian coefficients increases. From 2.3 to 85 melting, this increase is largely a consequence of non-Henry's lar behavior of REE in minerals. At melt percentages 29%, changing temperature and melt corposition, on well as non-Henry's law behavior, elso increase in Engetry telyment ince 2 to 188 melt part at 188 melt percentages in Despirition coefficients. The total increase in Despirition coefficients.

The total increase in DRECTYPTED coefficients. The total increase in DRECTYPTED coefficients. 38% self pay be up to 100% for some minerals and REE, and the ossumption rade in petrogenetic modeling of constant partition scofficiants in therefore quotelloned.

Experimentally determined REE abundances in the 2.3 and 8% melts can be adequately redeled with an equilibrium poetici relting model and o maling reaction, determined by Hyper [1977a]. In the ayetem Cab-Hyo-Al-20,-S10:

gernet + 0.67 dipride + 0.14 enstatized.22 forsterite + 1.61 liquid.

REE abundances connot be calculated at hipher parcentages of melting because the melling reaction is est known.

The REE enrichment in the 2.3% melt in 22 times chandritic abundance, and this melt has chondrite energalized Coffm 4.18. The generation of REE obundances typical of most sixely basalts (ce enrichment 40-208 and Coffm 2-15) for not possible even by low percentages of portial malting of a permet thercalito unions the material has been enriched in LREE relative to chondrites.

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\$230 Superimental mineralogy and patrology SIGH-PRESSUME STABILITY AND THERMODYNAMIC PROPERTIES OF COSIG, Steven R. Bohlen and A. L. Boattcher (incrirute of Seophysics and Floralery Physics sed Department of Earth and Space Sciences, University of California, Los Angeles, California 90024).

Ve determined the stability of CoSHO, relative sed CogBio, 4810, ulrb reversed experiment in a placto-oplinder apparates. Our date at 1023, 1175, 1325, and 1275 K indicate Instability of CoSHO, relate 17.2, 18.0, 19.1, and 20.1 Eberados and Affect from exiden) anicolated free cot date between 900 and 1903 K are -12.520.2 bit and -8.010.8 kJ, respectively. The dryot mispes of phase cramformations in Fa-bearing system in plemetery interfore that are inferted from Complete Properties, bigh-preseurs pheres, experientel sinarties, bigh-preseurs pheres, experieentel min scalogy.) Sacphys, Res, Lett., Paper 11.0507

\$230 Seperimental mineralogy and petrology
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Videls | Los Alamos Sev Henico \$7549, 1883)
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Osaphys. Res. Lett., Paper 110732

4230 Mineral onsurrences and deposits
THE CRYSTAL STRUCTURE OF A PERIODAL ATINITY
J. Seven Swinces (Heisriele Science Liburasories, Department of Chemical Engineering.
The University of Taxes at Austin, Austin;
Texas, J8719) Hogo Stalofink, L.E. RandonBiazhiros and S. Ructeo de le Vege
A nive opportance of maintee and its chanical
composition is reported. A three-dimensional
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autised on; using 3,124 observed structure
ampitudes. The racinemant converged to
any 1015, MR = 0,830. The MgGT, MnT, and
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146 Farageesis, petrography, and petrogensis CZEMISTRI OF EXCE-FORMING MINERALS DY THE CHINESPA-PALBONES EXTRICTED IN SQUINGESTERS JANK NO LIGILIZATIONS DE MASKA CHISTER JANK NO LIGILIZATIONS DE MASKA CHISTER JANK NO LIGILIZATIONS DE MASKA CHISTER GARLO CHINTRE MAD ALCOHOLIZATION DE MASKA CHISTER MAD ALCOHOLIZATION AND ACCIONA SA LIGITATION AND ACCIONA FOR SERVICIONA SA CHINTRE SA CHINTRE PROPERTY OF THE MASKA CHINTRE SA CHIN

AGO Progensis, petrography, end petrogenesis CALDONIAN PLUTONISM IN SRITAIN:
A SUMMARY
G.C. Brown (Department of Earth Salenaes, The Open University, Milton Keynes, MK7 6AA, UK) J. Cossidy, C.A. Locke, J.A. Plent and P.S. Simpson
The Caledonian grantise of Britain are a wide-renging suits of gre- and post-inctonic benefits-groundstrities and green and the frequency of introducts and the frequency of introducts in the time introducts and the frequency of introducts increased with time ar riceus of the lapates access occurred ceress the Colected belt in the British Irles. Early pre-tectonia and past-increased introducts (after than about 410 Ma) are distinguished from a being (post-410 Ma) group using polyvicel (gravity, percengantic and heat production) or distinguished from a later (post-410 Mo) group using apolysical (grafty, aeromagnetic and heat production) and geochemical delta. The soldence is interpreted in tens of a tread with time from a slott voly local thermal and auxi-dominated mailing events to a final widespread sailing event at desper levels. The latter event produced abundant intrutions with characteristics that restrained in a selecular linear with characteristics that restrained in a selecular linear with characteristics and carried in a final widespread to the control of the growth during the Caledonian paried took place by nor thwards according to the final paried took place by nor thwards according to the interpretation of the control of the final paried for the secretion of the restlemental crust on both margins by underplating and by later intrustre magnetism. undeploting and by loter intrutive magmettem.

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\$260 Paragenesis, petrography, and potrogenesis GEOTHERMOMETRY AND KINETICS IN A TWO-SPINEL PERMOTITE NOBULE, COLORADO PLATEAU

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alto Feragineria, patrography, and patrogenesis alto Serialis De ECCOLTES AND PRESONTIES FROM PRESONTIES FROM PRESONTIES FROM PROGRAMMENT AND LIGURAN ALPS V. S. Event (Sept. of Earth and Espace Sciences, Christip of California, Les Angeles, CA 9007th Alcahema peridotites and sciences of the Matter and in the California in the California periodites and science place and particularies. Especial control of the Matter and Indiana Passa compositions, and half-rock REF altagor sistems the second test respect to the Stratillatous ultranafic less amposed at Alps Stratillatous ultranafic less amou light ESE deplections due in the peridocites amou light ESE deplections due in the peridocites amou light ESE deplections due to harde the peridocites and situation of martic complexity oblitered generations of martic firedy free located resiste co prisontial REE deplections between the extra stratillation of Front Stratillations and Stratillations and Stratillations and Stratillations and the California of the Stratillations of Indianafic and Theorem and Stratillations and the Stratillation Stratillations of Othermafic and Section Stratillations of Othermafic and Section 181 and 181 a

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A770 Proporties of minerals

0. Cramer and O. S. Usimanu (Messchusets
institute of Tashedlogy, Cashridge, M. 02139

Viscosities of sweez Compentions in the
albita-morthite system [Abaganza, Abaganza and
Abiganys) were measured over a wide range of
respecture [800-1850*3]. The log n wrams [//
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[7-1200*9], the viscosity locrasers monotonically with increasing Ab content; but the change
of viscosity with temperature increases with
increasing An concentration. Sence the
viscosity-temperature registions show a togion of
cross-over; and at sufficiently low temperatures
[12/50*9], the viscosity increases with
increasing An concent. The predictions of
models based on iros-volume theory and the
meal-amprical models of Bottings and Uniti
and Show are in close accord with the data
within + 0.2 in leging in mostly all reases).
(Viscosity, Albirr, Amerthica)
J. Goophys, Ras., had, Papat 180617

4270 Properties of minerals

MATURAL ANNEALING OF PLACKPOIC MAIOUS IN SIGHTE SAMPLES FROM SEEP DRILL HOURS, FENTON MILL, NEW MEXICO

Randy Lanay and A. William Loughlin (Ceonclances Division, Los Alances National Laboratory, Los Alances, New Maxico 87545]

Examination of 46 thin-sections of Pracambrian matamorphic and ignous rocks from three does drill holes in northern Hew Mexico reveals a narrow depith-temperature range for annealing of piscocheric beloes in biotice. Annealing of the haloes is first observed in earples iron a depth of 1970 m 1134°C present respectature of annealing complete in semples from a depth of 1970 m 1134°C present comparature of annealing of the haloes is in good agreement with earlier observations of liesion exact annealing in apatics from the sums core samples. (Maio annealing, radioactivity).

Geophys. Fee. Lett., Paper 1105VI

A-ZAU FROMENTED Of MINERAL SIN-MEAS-INFRANCO SECTRAL REFLICTANCY OF MINERAL SIS-TURES: AYSTEMATIC COMMINATIONS OF PYROMENTS, OLIVER, AND IRON OXIGES S.S. Singer Pilosetary Geosciences, Mayall Inst. of Osophysics, Poly. of Harsil, Honolalu, El 988221 4210 Properties of minerals

Mean-infrared spectral reflectance data are presented for symiansic variations to weight percent of two component mistures of ferro-magnesian and iran-onide miscusis. Mixtures were chosen for upplication to the study of the dark meaning is on Mara, but he results are quality applicable so mais and ultramefic essemblages elsewhere in the solar spaces. Olivine spactral features era grantly reduced in contrast by admirature of other phases but results distinctive even for low olivine spactral features era grantly reduced in contrast by admirature of other phases but result distinctive are miscussed to make prices mear 2 us. The edition of limonite grantly modifies pyrosens and olivine reflectance but does not fully eliminate distinctive apactral characterilaties. Using only spectral data in the i-so region in 1s difficult to diffarentiate orchopyrosess and limonite ignotities in a mixture. Additional spectral courage or other avidence may be required for a unique interpretation. All composits mineral absorptions observed for this study are either weaker thes or invariance in strange to the analysis of the sendsectors. In general, cyactral proparties is an intiext entire vender these or invariance and the regulation than the regulation of and and the propertions.

J. Geophys. Sea., Red, Paper 180711 Near-infrared spectral reflectance data are

4290 Instruments and tachniques
ION MICROPPORE TECHNIQUES AND ANALYSES
I. M. Stecle, S. t. Hervig, T. S. Buchson and
J. V. Smith (Department of Geophysical Stiences,
University of Chicago, thicago, IL 606f7).

Experiments conditions for majos, since Cod

Experimental conditions for major, and trace alemont satisful of cilvina and low-Capyroness are described and analyticat acturing tested using suites of neutral semples speaming a wide range of Nighta.

Special eltention are given to amples alemnimenes to avoid contentiation, landromental recurse to minimate hydrides in the secondary ion spectrum which are separated from the secondary ion spectrum which are separated from consistinal peaks using same resolution (NIAM) over 2000. Caccala scalars of the secondary ion spectrum which are separated from consistinal peaks using same resolution (NIAM) over 2000. Caccala scalars of the secondary ion spectrum slicoed choics of alther high or less seas requirition depending on the presence of interferences. Lithium (0.055), F (LI), Ma (0.1), Fa, and Co (I) were scalared by the consisting of the consisting

include (a (1), Sc (1), H (f), V (1), Cc (1) and M (5).

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Particles and Fields-Magnetosphere

1726 Interactions between solar wind and magnetic-ORGANIZATIONS OF IFFECTS FROM MACHITASPHEDIC COSP sphere
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0. Streen (Mar-Fisch fearilists for Aeronomy
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A. Servin and R. J. Lenning ichro Rophins University Laurel, Mavyland 20815) d. T. Sarris and R. J. Lapping

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The spatial distribution of energetic particles in the distant respectful is sampled by using identical acts of two complementary energetic particle services experiments about the 1997 and B spacecraft. The confined twist and 4 days was provided nearly in years of eatellist observation. The quantitative distributions of energetic electrons in two energy tragges to between a latest and the services of energetic protons this says in a 200 fety, 230 last a g. 3 but key are preceded in terms of our energetic protons this says in a 200 fety, 230 last a g. 3 but key are preceded in terms of our energetic protons this says in a 200 fety, 230 last a g. 3 but key are preceded in terms of our energetic protons this says in a 200 fety, 230 last a g. 3 but key are preceded in terms of our energetic protons to the animal fine. Use 10 security is a partial distribution over the solar regeneration in the nationary direction in elective decementaried it All energies artifure both appealed to the magneto-december protons and for the security distribution. A distribution that have a security distribution and the content of the places in the distribution in the capacity of the particle distribution and the interest of the electrons and prisons and in the evening side. The degree of asymmetry different for electrons and prisons and it energy because in distribution and it energy because in the places and prisons and it is a larger and an electrons and prisons and it is a larger and an electrons and prisons and it is a larger and an electrons and prisons and it is a larger and an electrons and prisons and it is a larger and an electrons and estely one order of bigattude. J. Geophys. Res., Sium, Asper tadag:

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F.L. Aritchett Department of Physics, University of California, Los argeles, CA 3/024]

M. Ashour-Abdalia and J.M. Devion

Asticle simulations are employed the a selfconsistent investigation of the growth and satu
ration of current-driven instabilities afora

astoral liad dibas. Ion exclotern waves are

found to grow to levels ea/W₂ · 0.2 - 0.4, which

are comparable with the invest observed by the

Si-1 satellits. In the present initial-value

calculations, asturation is due to plateau form
ation on the electron distribution function.

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miserate t. 4011 perpendicular heating of the

loss but does not produce a high-energy tail.

The associated accompleus resistivity is rela
tively e-all, Jugo 1 is 10°. Implications of

Fince resulas for chiervation of top cyclotron

waves on lustral field light are discussed.

Gomphys. Res. Latt., Pager 110/26 Gomphym. Res. Latz., Paper 110/26

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THE ROLE OF HISS IN MACRETOSPHERIC
CHORUS Extissions
II. C. Keans IThe Agraepaca Corporation,
P. O. Son 94937. Los Angales, CA 90093
Many researchers have reported that agrowhand him emissions are simultaneously passent
with oil chorus assistions outside of the plearmasphere. In data frose the SCATIA catelitie
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H.Bingh(Department of Physics, R.B.S.,
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and Raingh
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such that the waves aculd not be aboarvad on the ground. In the absence of
suitable ducts horizontal density
gradiests existing to the low latitude
lonosphere seem to play important roles
in whistler propagations to ground
stattoes (Whistler elegant fields;
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J. Gosphys. Ras., Ztus, Fesc 140319